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The Institute of Vitreous Enamellers

The Welsh Engineers' and Founders' Association

and

The Foundry Trades' Equipment and Supplies Association

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Cupola Blast Pressures

In recent years there has been a tendency in cupola practice to soften the blast, associated with some vague notions about heavy oxidation, high silicon losses, and various other deleterious effects. At last results of a systematic investigation into the effect of blast pressure in cupola melting are available. It has been conducted by Dr. Mackenzie and Mr. C. K. Donoho, of the American Cast Iron Pipe Company, and presented in the form of a Paper to the recent meeting of the American Foundrymen's Association. Their results are so interesting that they are well worth repeating under the conditions obtaining in the various works. A coke ratio of 10 to 1 was used when dealing with an all-scrap charge, and a somewhat heavier one (8 to 1) for 1.75 per cent. silicon steel pig (carbon 0.68 per cent. average). Blast pressures for the all-scrap charge went up by increments of an ounce from three to twelve. The experiments were performed in a 21-in. inside diameter cupola, and a magnesium limestone was used as a flux. For the all-scrap charge it was found that with increasing pressure the melting rate was accelerated from 600 to over 1,400 lbs. per hr.; the temperature of the metal at the spout from about 1,390 to 1,470 deg. C., if the 1- and 2-oz. blast experiments be omitted. Continuing with this omission, the experiments showed that the carbon pick-up diminished from 0.125 to 0.06 per cent. up to 7 ozs. blast pressure, then increased to about 0.09 per cent. with 10 ozs., after which it fell off to 0.04 per cent. at 12 ozs. The sulphur pick-up followed a similar line to that of carbon, and in general decreased from 0.07 to 0.05 per cent. The manganese loss increased rapidly from 15 per cent. with a 3-oz. pressure up to 21 per cent. with 5 ozs. and then decreased to 17 per cent. at 12 ozs. The silicon percentage loss showed progressive increase from 7.1 to 10.5. For the high silicon steel the silicon loss rose from 11.7 to 14.3 per cent. So far as the mechanical properties are concerned, using the transverse test as a criterion, the strength of the material decreased slightly at 5 ozs. pressure and then rose sharply at 7 ozs., decreased somewhat at 10 ozs. and rose again at 12 ozs.

As we emphasised initially, these results refer to a particular set of cupola conditions, and before general acceptance they require confirmation under a series of differing circumstances. The major lesson to be learnt from them is that wide variations in blast pressure do not induce undue variations from normal, except for some expected changes in analysis. Their major use is the acceleration of output, which on occasion can be a very useful factor. The wide elasticity of cupola operation is again made evident, but it should not be an excuse for lack of control.

Bismuth in Foundry Practice

We recently had a long conversation with a metallurgist well versed in the subject of bismuth alloys, and as a result we are of opinion that more information should be disseminated about this essentially useful metal and its alloys. By alloying it with mercury, unstable alloys, with a melting point of 40 deg. Fah., can be produced, but the eutectic mixtures in combination with lead, tin and antimony, some of which melt at temperatures as low as 71 deg. C., are particularly useful for the manufacture of master patterns. Instead of shrinking, they are inclined to expand slightly, and this may account for the exceptionally brilliant manner in which they reproduce every detail of the pattern. Cast against a bank note, even the water mark was revealed, and we can well believe the assertion that a suitable alloy will reproduce a thousand lines per inch. A use to which these low melting-point alloys can be put with advantage is the casting of it round a pattern, and then plating it with iron or nickel. Having done this, the alloy can easily be melted away from the coating, and the interior filled with the metal to form a master pattern. Actually, for this purpose a eutectic alloy of lead and bismuth melting at temperatures ranging from 132 to 154 deg. C. is recommended. This would yield a Brinell hardness value of 10.2 and a tensile strength of 2.7 tons per sq. in. This is obviously a fairly soft material, but master patterns are not intended to be used as working patterns, and should they often be required, then it is perfectly easy to plate them with a hard-wearing surface. Obviously, such alloys are expensive, but they are so easily remelted and re-used that there is no important wastage. Another use is the making of ornamental castings by silver plating a low melting-point alloy having excellent casting properties. It can be cast against the model, silver plated and the aperture so formed filled with a base metal. Finally, as an experimental alloy, this bismuth group shows the greatest potentialities owing to low melting temperatures, good casting properties and absence of shrinkage. With increased knowledge of their properties, the field for their use would most probably be widened, because cost of rehabilitation is extremely low.

Correspondence

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

Steelmaking Symposium

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—The writer was much interested in your commentary under the heading of "A Steelmaking Symposium," which appeared in the issue of the JOURNAL dated May 12. Having taken the opportunity of examining the Papers comprising the Symposium, one could not but appreciate that a tremendous stride forward has been taken during recent years, in matters relative to the production of steel by the open-hearth processes.

The obtainance of steel by these and other processes for the production of castings is a subject of vital interest to founders, and they will agree with your reference to the Paper on "The Application of Physical Chemistry to Steelmaking," by Dr. McCance, whose contribution is an excellent one in its practical and therefore helpful remarks regarding the excess of deoxidisers, and concerning those reactions inseparable from steelmaking.

Founders welcome a contribution as instructive as that by Dr. McCance as one being of the greatest service to them in the production of a cleaner steel for their castings. Important points are:—The correct deoxidisers and the exact time for additions; quality of pig-iron and scrap; gas; and obtainance of metal low in sulphur, which subjects have been dealt with only briefly in most of the Papers in the Symposium.

At the works where the writer is engaged, there are in use two Tropenas converters, each of two tons capacity per heat, also a 10 to 20 tons Siemens open-hearth furnace. A considerable amount of work has been carried out by us over a long period with the object of obtaining as clean steel as possible, as the castings made mainly consist of those required to give good service under pressure and at elevated temperatures. Comparisons indicate that we obtain as clean a steel as elsewhere, yet it is quite obvious to the writer, as to every steel founder, that the steel produced is not as clean as he could wish, hence the welcome which will be accorded to the unusually instructive contribution by Dr. McCance.

Generally, the types of plant and methods of melting form the subjects dealt with by the majority of the Papers in the Symposium rather than the question of an improvement in the quality of the steel produced. Some smelters can obtain better results from a Tropenas converter than a Siemens open-hearth furnace, and *vice versa*. The writer has observed cleaner steel produced from an open-hearth furnace of forty years' service than that from the most modern furnace at present in operation. Does not this indicate, as you suggest, that there is necessity for a much wider collaboration between the technical and scientific aspects of steel production than is existing to-day?—Yours, etc.,

W. MACHIN
(Foundries Manager).

Vickers-Armstrongs, Limited,
Barrow-in-Furness.
May 20, 1938.

I.B.F. Golf Competition

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—The entry for the above competition, whilst quite good, is not representative of an Institute with such a large membership. We hope that all golfing members will come to the Matlock course on Sunday next, May 29, to give this new venture on the social side of the Institute a really good send-off. Even if you have not sent in your intimation to be present, do turn up and provide real competition for the excellent prizes offered.—Yours, etc.,

J. BELL.
J. W. GARDOM.
D. H. WOOD.
R. A. STILES.
A. G. ROBIETTE.

3, Cherry Street, Birmingham.
May 21, 1938.

Institute of British Foundrymen's Cricket Match

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—I am again arranging the annual cricket match between the Institute of British Foundrymen and the Works Managers' Association. The suggested date is Sunday, July 10, and the place Lichfield, as before. This is the third Annual Cricket Match, and I should like to hear from any members of the Institute if they would care to offer their services to play in the team. Perhaps those who would like to play will be kind enough to write to me direct.—Yours, etc.,

J. E. HURST.

"Ashleigh,"
Trent Valley Road, Lichfield.
May 18, 1938.

French Foundry Conference

The 17th annual Convention of the French Foundry Technical Association will be held at Lyons from June 9 to 11, under the presidency of Mr. H. Sandre.

The journey from Paris is to be broken at Nevers in order that the research laboratories of the Commentry-Fourchambault and Decazeville concern, which are under the direction of Prof. P. Chevenard, may be visited. This will occupy the whole of the first day, June 9. On Friday morning there is a visit to the works of the Berliet company and those of Séguin, and in the afternoon to the local technical school and a silk works.

On the Saturday there is to be a full technical session, at which the following Papers will be submitted:—

(1) "A Hundred Years of Cast Iron," by Prof. E. Diepschlag. (German Exchange Paper.)
(2) "Etching Reagents for Grey Iron, with Special Reference to a New Electrolytic Method," by Prof. L. F. Girardet.
(3) "Effect of Some Elements on Austenitic Acid-resisting Irons," by J. Challansonnet.
(4) "Influence of Special Elements on Malleable Cast Iron," by Jean Challansonnet.
(5) "Influence of Fluxes on the Wear of Cupola Refractories," by Guy Henon.
(6) "Monolithic Linings," by André Guedras.
(7) "Some Pertinent Factors in Sand Testing," by T. R. Walker, M.A. (British Exchange Paper.)
(8) "American Developments in Safety and Welfare Work," by James R. Allan. (American Exchange Paper.)
(9) "Rational Cost-Price Determination for Small Foundries," by Charles Denery.
(10) "The Standardisation of Copper-Lead and Copper-Tin-Lead," by Alfred Ricard.
(11) "Pattern and Core-Box Varnishes," by Georges Godel.

A banquet is to be held on the Saturday evening.

(Continued from next column.)

"Why, yes. I've got some of those things at home."

"Then what do you do with them if you don't play darts?"

"Oh, I kill flies with those things."

"And doesn't it make a mess on the wall?" asked his friend.

"Oh, no. I just pin them down by the back legs."

"MARKSMAN."

Random Shots

In the ordinary way, to think of Bradford is to conjure up pictures of the tall grey chimneys of the woollen factories, streets of warehouses for the storage of wool, and row upon row of factories for the wholesale production of cloth. In a few weeks' time, however, Bradford's hotel lounges will hum with unaccustomed dronings, for gossip about noils and wefts and warps will give place to whisperings of runners, risers and joints. Yet the curious fact is that there is only one manufacture in which these Yorkshire towns are really interested, and that is neither wool nor castings. It is "brass," good solid brass, put away week by week in the tea caddy on the mantelpiece in readiness for the annual week at the sea, or tucked away in the bank to swell an ever-growing account. In the old days when the woollen industry was in its heyday a man's worth was judged by the amount of "brass" he had made, and no master was considered to have arrived until he could sport a diamond tiepin, at least one jewelled ring and gold-handled umbrella, and a large establishment complete with cook and liberal staff of maids. To judge by a very recent will of one Yorkshire worsted spinner, who left £128,119 7s. 6d., their heydey is not quite over!

* * *

It seems that the ladies attending the foundry conference at least will be privileged to have a little insight into the real life of Bradford, for they will have the opportunity of seeing the mechanised tailor at work. In such factories the production of tailored suits has become the last word in Taylorism, as it were. Heaven forbid that when the ladies return home they will become dissatisfied with the simple scissor and sewing machine!

* * *

Talking of scissors, there are more ways of getting over a river than by rowing across. The Japanese have a habit of changing the name of a town to "Sweden" or "Macclesfield" in order to be able to put "Made in Sweden" on its matches and "Real Macclesfield Silk" on its rolls of silk. Only the other day "Marksman" discovered a pair of scissors lying on his favourite easy chair (as a change from a dozen pins or a pair of knitting needles!), and on them as large as life was inscribed "Made in Cheffield." There is more than a suspicion that those scissors came from America!

* * *

As for the latest domestic sewing machines, they are the cutest, smartest bit of workmanship that ever involved the use of small castings. They have little lights which chase away the shadows, shuttles which know what to do and just when to stop doing it, and a magic foot which can do a veritable *palais* glide!

* * *

It seems that the atmosphere of Bath and Cheltenham is definitely too chilly for foundrymen more accustomed to the comforting warmth of the open hearth. In fact, on their recent West of England tour, some of the London party felt a distinct relief when they were able to take off their coats and get down to a job of work when the motor-coach refused to budge. They can rest assured, however, that it will be a far from frozen welcome at Bradford, for although the Yorkshireman is reputed to be plain-spoken, blunt and often unimaginative, yet he has no small genius for real hospitality.

* * *

A man recently introduced his pal into his darts club for the first time. On noticing that he threw a "pretty dart" with a good eye and a steady hand, he asked if it were really true that he had not played before.

"Never thrown a dart before?"

(Continued in previous column.)

Grey Iron Foundry Control

METALLURGICAL AIDS TO PRODUCTION*

By A. R. PARKES

The time when any foundry which wishes to survive in the march of progress must have strict metallurgical control has arrived. It is especially true that a foundry specialising in the manufacture of large numbers of ferrous castings comes to depend more and more upon the standardisation of material, and the maintenance of standards within strict limits; it is the foundry metallurgist who is responsible for this. It has been said, "when things are going well, where is the need for tests, and when things go wrong, tests are too late." How far that saying is true there is no need to ask of a real foundryman.

The home of the metallurgist is in the laboratory, but, "just as a thousand arrows loosed several ways may come to one mark," so may a thousand reins of control have the laboratory as their centre. The essential quality of a laboratory in a repetition foundry is its capacity for accurate routine work, and all operations should be organised with that end in view. The economic dissemination of the results of physical and chemical tests in the light of experience is the function of the metallurgist. Analytical methods are now so well standardised that the first part of this condition is easy to obtain. In the second point, the real monetary value of metallurgical control may be gauged.

Buying

Metallurgical control starts with the supervision of the purchase of essential foundry raw materials. For thousands of years people have quoted that it is impossible to make "bricks without straw," yet how often even nowadays is a metallurgist asked to make good castings with materials he has not, and would not have, bought? Often foundry materials are bought on competitive price without consideration of metallurgical value.

Heap. 88.
40 tons Derbyshire N° 3 Pig.
trucks. 91289, 856363, 7449, 39334.

rec'd. 11-8-37.
anal. 12-8-37.

	Maskens' Analysis.	Our Analysis. S. 383	S. 384	S. 385.	Mixed Samples.
T.C.	3·60				3·52
Si.	3·25 – 3·50	3·31	3·58	3·43	3·42
Sc.	·06 max				·053
Ph.	1·0 – 1·3.				1·23
Mn.	·8 – 1·2.				·98.

Commenced:–
Finished:–

FIG. 1.—SPECIMEN STOCK CARD.

Laboratory Routine

Pig-iron, scrap, sand, coke and limestone are a few of the materials which are usually bought in by the foundry, and which should be regularly tested. For instance, pig-iron consignments should be sampled in an approved manner on receipt and their analysis recorded on stock cards such as is shown in Fig. 1.

The average analysis should be used for all mixture calculations where this iron is to be a constituent. When the heap is used up the card, of which Fig. 1 is a replica, should be relegated to the obsolete portion of the file. For accurate work only shop return scrap is permissible in a mixture, and this, too, should be isolated in different heaps and analysed. Samples of drillings can conveniently be "filed" in 4 in. by ½ in. test-tubes with the number on the cork. This method of retaining drillings for a period is to be preferred to the packet system, because of the risk of contamination which is ever present with the latter. Then, in the event of a consignment of iron being rejected, or in the case of any complaint or dispute, samples are to hand for independent analysis. The handling of a complaint is indicated in Fig. 2. All raw materials can be checked and the results of tests placed on a card file in a similar manner to Fig. 1, so long as each filing card has a cross reference.

Periodical check tests are carried out on coke for its sulphur, fixed carbon and ash content. Sand is checked as often as possible for moisture content as delivered to the moulder, and, periodically, for bond strength, permeability, etc. Bought-in scrap is analysed by mixing samples taken from at least ten representative pieces per truck load. Shop-return scrap is taken to be of the same analysis as good castings, and, at this metallurgical value, is re-charged to the furnace. For costing purposes, as will later be explained, returned scrap is not valued at all where foundry and melting shop are treated as one unit.

S. 498.
Flywheels returned from Messrs D & A.
Supposed to be hard. see letter LJ/ES. 8-4-37.

rec'd. 12-4-37.
anal. 13-4-37.

	Specification	Drillings taken from the wheels.
T.C.	3·40	3·46
Gr.C.		2·80
C.C.		·66 (by diff)
Si	2·40	2·33.
Sc	·08 max	·076
Ph.	·80	·84
Mn.	·60	·81

Micro:– No trace of free cementite.
Remarks:– Complaint not justified.

FIG. 2.—REPORT CARD RELATING TO CUSTOMER'S COMPLAINT.

Metal Mixing

Before a mixture of pig-irons, etc., is charged into the cupola, its estimated and theoretical resulting analysis should be worked out on a card, which is filed after approval. Starting with the four metals indicated in Table I, the most important element—silicon—is considered and the various amounts of the irons to give this required silicon content, consistent with economical working, are decided upon by "trial and error" methods. For this purpose, the percentage of the element present in the iron is multiplied by the amount of each iron it is desired to use in the mixture and the results added together and divided by the total charge thus:—

TABLE I.—*Composition of Materials in Stock.*

	Pig-iron A (refined).	Pig-iron B (common).	Bought scrap.	Shop scrap.
T.C ..	3.00	3.40	3.52	3.45
Si ..	3.05	2.95	2.23	2.28
Mn ..	1.70	1.05	0.73	0.80
S ..	0.04	0.03	0.085	0.08
P ..	0.55	1.00	0.81	0.83

15 per cent. of pig-iron A at 3·05 per cent. Si contributes $\frac{15 \times 3 \cdot 05}{100}$ units = 0·46 per cent. Si.

45 per cent. of shop scrap at 2·28 per cent. Si contributes $\frac{45 \times 2 \cdot 28}{100}$ units = 1·02 per cent. Si.

The above amounts are fixed for economic working. Bought scrap and common pig-iron are next varied to give the desired silicon result. It is found that:—20 per cent. bought scrap at 2.23 per cent. Si contributes 0.44 per cent.

* Paper awarded second prize in the Coronation Competition organised by the Lancashire Branch of the Institute of British Foundrymen.

silicon, and 20 per cent. common pig B at 2.95 per cent. Si contributes 0.59 per cent. silicon. This gives a total theoretical silicon of 2.51 per cent. In melting, however, a loss of silicon

Mx. 103. for 27. 7. 37.

Castings up to ½" section.

	Heap.	T.C.	Si.	Su.	Ph.	Mn.
15% Pig Iron A.	218	·45	·46	·006	·083	·25
20% Pig Iron B.	232.	·68	·59	·006	·200	·21
20% Bought Scrap.		·70	·44	·017	·162	·15
45% Shop Scrap.		1·55	1·02.	·036	·374	·36
100						
Theoretical.		3·38	2·51	·065	·82	·97.
Loss or Pick Up.		+·10	−·25	+·02	+·04	−·15.
Estimate.		3·48	2·26	·085	·86	·82.
Actual.		3.51	2·28	·083	·84	·82.
(cast. 27. 7. 37.)						

Fig. 3.—Specimen Card for Recording Mixtures.

occurs (varying according to conditions); this is assessed from experience and deducted. Thus one obtains the estimated silicon content of the iron when melted. The other elements are then determined, and, if, necessary, amounts of pig-irons, etc., re-adjusted. In this way a complete mixture as illustrated in Fig. 3 is drawn up.

The first cast made from the mixture is analysed, and the actual results recorded on the mixture cards. These mixture records are of inestimable value for tracing faults due to inefficient cupola operation, non-homogeneity of materials, for duplicating satisfactory or high-class iron, and for ensuring iron to guaranteed analysis every day. The method is difficult to describe, and, doubtless, sounds cumbersome, but with the aid of a slide-rule a mixture of as many as six irons containing seven constituent elements each may be drawn up in two or three minutes.

Cupola Control

The actual operation of the cupola is the next phase of foundry practice which calls for strict control. Cupolas are, like individuals, very temperamental; they often have vagaries that have to be humoured, and many excellent Papers have already been written on this subject. A home-made device for recording blast pressure for volume and control may, however, be of interest. It follows the lines of that detailed in "Foundrywork and Metallurgy," Vol. IV, edited by Rolfe.

It is general knowledge that both blast pressure and blast volume are necessary data for controlling a cupola. The first may be measured by a simple water U-tube manometer connected to the blast pipe, of the type shown in Fig. 4. The open limb is graduated in inches of water pressure, and the reservoir is connected by ¼ in. dia. copper pipe to the blast pipe. The second value (blast volume) is measured by a Pitot tube in the blast main working in conjunction with a differential manometer which records pressures in hundredths of an inch. The Pitot tube itself may be made as shown in Fig. 5.

A is a thin-walled metal tube of approximately ¾ in. dia. and 7 in. in length. The cork *B* at one end is perforated to take the open ⅛ in. copper pipe *C*, which runs through the tube and to the differential manometer which is fixed in a horizontal position on a wall near the cupola. The protruding part of cork *B* is "streamlined." Orifices are provided at *F*, in the form of 1/32 in. dia. drilled holes, eight in number, round the circumference of the tube. The static pressure pipe *E* leads from the chamber between the two corks *B* and *D* and is taken outside the main to the other end of the differential manometer tube. The Pitot tube is fixed in a straight length of blast main, in line with the blast direction, and the open end of tube *C* facing the blast source, as is shown in Fig. 6.

The differential manometer, shown in Fig. 7, consists of a reservoir *H* and an inclined limb slope 1 in 10 of glass tube, *I*. Any movement of the liquid level in the manometer is magnified by 10 in the tube *I*, and this movement of the liquid is read off on a scale graduated in hundredths of an inch pressure. Velocity or dynamic pressure tube *C* and static pressure tube *E* are connected by short pieces of india rubber tube to reservoir *H* and inclined tube *I* respectively. With this apparatus the blast pressure and volume of the cupola may be ascertained by calculations and calibration with a standard anemometer (see "Foundrywork and Metallurgy," Vol. IV) and the instruments calibrated to read direct.

Foundry Work

The metallurgist has little to do with the actual moulding and productive labour in the foundry. It is his duty to see that materials—sand, molten metal and the like—are correct in every way. Nevertheless, he is often consulted when "difficult" castings have to be made, and then an expert knowledge of foundry practice and mould design is essential. Trouble in the foundry in the shape of scrap castings comes home to the metallurgist first. It often happens that alterations in casting technique can cure defects that even experienced foundrymen would put down to defective metal, *e.g.*, drawn and spongy castings, cold shuts, contraction cracks, etc., can often be traced to bad mould design. For example, with the mould illustrated in Fig. 8, for a "dumb-bell" gear-blank casting which is to be machined all over, castings were continually defective, due to "drawn" top surfaces and "sponginess." Here it was found that, by running the castings separately at the top, and through a strainer core, clean sound castings could be obtained every time. Close co-operation between foundry execu-

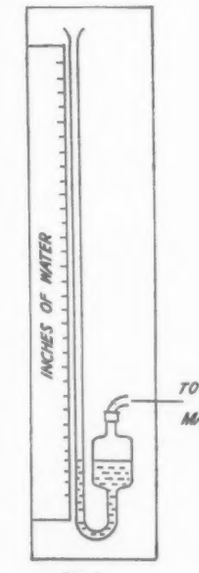
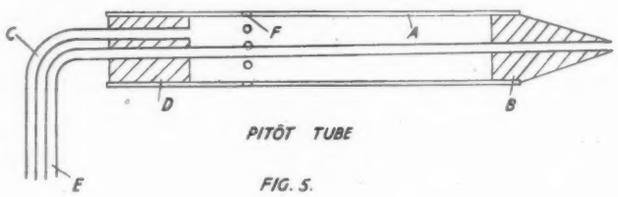
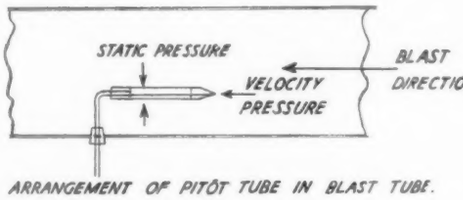


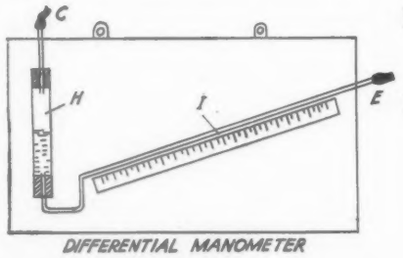
FIG. 4
BLAST PRESSURE GAUGE



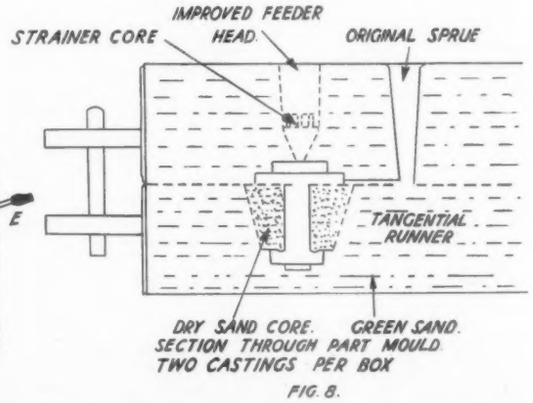
PITÖT TUBE
FIG. 5.



ARRANGEMENT OF PITÖT TUBE IN BLAST TUBE.
FIG. 6.



DIFFERENTIAL MANOMETER
FIG. 7



SECTION THROUGH PART MOULD. TWO CASTINGS PER BOX
FIG. 8.

tives in place of the too-prevalent barely masked mistrust provides the soundest basis for solving these casting troubles.

(*Concluded on page* 430.)

A Fresh Milestone in the Development of Cast Iron

By A. B. EVEREST, Ph.D. (Mond Nickel Company, Limited)

A few weeks ago a new milestone in the development of iron foundry practice was passed, in the publication by the B.S.I. of the new specification No. 786 covering high-duty cast iron. Previous to the preparation of this new specification the highest strength officially recognised as a national standard for general grey iron castings was 11 tons per sq. in. (on the 1.2 in. diameter bar). This is the minimum strength figure quoted for grade A castings in the specification No. 321 originally published in 1928 and re-issued in revised form in 1938. The new specification bears remarkable testimony to the rapid strides which have been made in the intervening decade in the production of high-duty castings, in that it is, of course, based on the strength figures now commercially available in iron castings as a result of the progress made in such directions as alloying, heat-treatment and other special processes such as inoculation.

A comparison between the figures included in the two specifications is given in Table I, which

TABLE I.—*Typical Tensile Strength Figures.*

B.S.S. 321—1938 (original 1928).			B.S.S. 786—1938.		
Bar diam. Ins.	Grade C.	Grade A.	Grade 1.	Grade 2.	Grade 3.
0.875..	10	12	15	18	22
1.2 ..	9	11	14	17	20
2.1 ..	9	10	12.5	15	18

shows some of the typical figures for the tensile strengths specified for different sizes of bars. A corresponding increase is, of course, shown for the other mechanical properties specified, such as the transverse strength.

Before analysing the figures in the new specification, it is as well to recollect that all these figures are minima; that is to say, for all castings bought, for example, to Grade 3 and represented by the 1.2 in. diameter bar, the minimum strength acceptable is that shown in the table, namely, 20 tons per sq. in. This means that in supplying castings to comply with this specification the foundryman must actually aim at a strength some 2 or 3 tons per sq. in. higher in order to allow an ample margin of safety to take care of variables in the foundry and to ensure that all his castings will pass the inspector.

Grade 1 and Alloy Additions

Considering the figures in the new specification in detail, it will be appreciated that Grade 1 corresponds to a modern good-quality engineering or cylinder cast iron as produced in many good foundries where reasonable technical control is exercised over the metal mixtures, and melting and casting technique. This grade of iron is suitable for a wide variety of engineering castings where reasonably good all-round properties are required.

Generally speaking, the use of alloy additions in this grade of iron is not necessary from the point of view of strength or the other mechanical properties specified. As in the other grades of iron, however, the use of additions such as nickel may be of value in assisting the foundryman to produce good and satisfactory castings, especially of difficult shape and which at the same time comply with the strength figures specified. The value of nickel in this type of iron is specially to promote uniformity in castings of varying section, and in ensuring pressure-tightness in thick sections or in castings with lumpy parts or with conjoining sections. Again, nickel additions may be used in this type of iron to eliminate any tendency to chilling and hard spots which may occur in thin sections or at corners and edges of the castings, and interfere with machining operations.

Alloy Cast Iron

Grade 2 of the new specification corresponds to the general class of alloy cast iron as used for high-quality engineering castings to-day. This represents especially a type of iron which has come into general use within recent years and the successful application of which depends to a large extent on the development of alloy additions. Iron of this type is generally made by melting charges containing greater or smaller proportions of steel scrap in the cupola and exercising careful control over the melting conditions. Alternatively, this grade of iron is made in the rotary or air furnace, in both of which control over the charge of raw material is necessary to ensure the correct composition required to meet the specified strength figures.

Counteracting Low Silicon

Generally speaking, a low silicon content is essential in iron of this class to ensure high strength. This, in turn, is beneficial in giving density and strength in the thick sections, but tends to lead to chilling and machining troubles in the lighter parts of the casting. Thus, the practical difficulties involved in using an iron of this type in the foundry arise mainly from its great sensitivity to cooling conditions as obtained in different sections, and also its sensitivity to melting conditions and minor changes in composition. The use of nickel additions ensures freedom from chill, giving consequent machinability in the thin sections whilst they add further to the density and strength of the thick sections, thus minimising the variables which are shown to so marked a degree in this grade of iron.

Within the past few years alloy cast iron which would correspond to grade 2 in the specification has become widely adopted for engineering castings of all types. Typical examples are found in machine-tool frames, in engine castings such as cylinders and flywheels, in gear wheels and other large castings subject to moderately heavy duty, and especially to such large and lumpy parts as press dies in which a combination of good strength and wearing quality is desired.

Special Cast Irons

The strength figures quoted for iron of Grade 3, generally speaking, can only be met by the use of special melting equipment and foundry technique. This grade of iron is generally made in the electric or rotary furnace or, alternatively, by the melting of charges consisting mainly of steel scrap in the cupola, and followed in each case by the use of suitable alloy additions and inoculation. Irons of this class can easily be produced with strength figures well within the specification limits and, in fact, figures far in excess of these are often achieved. It is interesting in this connection to mention that a suggestion was actually made (FOUNDRY TRADE JOURNAL, February 21, 1935) that the new specification should cover grades of cast iron even up to the range of 24 to 33 tons per sq. in.

"Ni-Tensyl"

Accepting the figures given for Grade 3 as minima, it has already been established that a wide range of engineering castings can be produced in special process irons to comply with this grade. One of the best known of the special process irons fulfilling these conditions is "Ni-Tensyl," which is now well established in modern engineering practice. This iron can be taken as typical of those meeting Grade 3 in the new specification. It is produced, generally, by cupola melting charges consisting mainly of steel scrap and by suitable alloying and inoculation to yield a grey cast iron of extremely fine grain and with high strength and excellent characteristics. It should be mentioned incidentally that, for small castings, especially parts such as gears, cams, etc., iron of this grade can be further improved to a marked extent by means of heat-treatment, strength figures in the range between 30 and 40 tons thereby often being reached.

One of the surprising features of the nickel-containing inoculated cast iron—"Ni-Tensyl"—is its great adaptability. Criticism of high-strength irons has frequently been based on their supposed sensitivity to cooling conditions, as mentioned above, and for this reason engineers and foundrymen have often considered that iron in this grade is only suitable for heavy castings. One of the most striking features of "Ni-Tensyl" is the fact that it is equally suitable for castings with large sections as well as for relatively light parts, and foundries in which a number of grades of iron have in the past been run for castings of different types have since found that, on adopting "Ni-Tensyl," they have been enabled to turn over their complete production to one standard grade of inoculated iron produced from the cupola or rotary furnace.

As would be expected from this, there is at the same time a remarkable degree of uniformity in the strength figures shown for "Ni-Tensyl" in varying sections; stating the case differently, the falling away of strength with increase in section in the case of "Ni-Tensyl" is appreciably less than normally associated with high-duty cast iron. This, again, has an influence in promoting greater uniformity in castings with varying section.

Another feature of special interest in connection with high-duty cast irons is their hardness and wearing quality. There is a tendency for non-alloyed high-strength cast irons to be somewhat harder and more difficult to machine than the lower grade softer irons. This difficulty does not arise in the case of the special process irons, such as "Ni-Tensyl," and, in fact, although the Brinell test shows the hardness often to be as high as 260, the machinability of the irons is excellent, and is usually reported as being better than that of the plain iron previously employed. This high hardness is associated with excellent wearing quality.

Field for Application

The highest grades included in the new specification are intended essentially for high-quality castings for use under conditions where toughness and high strength are required, especially in cases where high stresses are imposed, or where it is desired to reduce section thicknesses. Castings, especially in the case of Grade 3, are intended rather to fill the gap between cast iron as previously known and cast steel, and, although no claim can be made that the new high-duty irons can successfully replace steel, they are, however, of interest for many applications where something with a strength approaching steel and without necessarily requiring its ductility is desired.

For many castings it may not be necessary to go to the higher grades as indicated in the new specification, but in the case even of the lower grades of iron, as indicated above, the use of alloy additions is often beneficial in conferring properties such as pressure tightness and machinability where something a little better than the plain cast iron is needed.

Heat-Treatment

Although the question of heat-treatment is only given passing reference in the new specification, irons of the higher grades may in many

(*Concluded on page 430.*)

London Foundrymen Visit the West Country

A party of about 18 members of the Institute of British Foundrymen left London by motor-coach on May 10 for a three days' tour of foundries in the West Country. Included in the party were the London Branch-President (Dr. A. B. Everest), the Junior Vice-President (Mr. H. W. Lockwood), Mr. V. Delport and Mr. R. J. Shaw (Past-Presidents of the Branch).

SOME OF THE MEMBERS OF THE PARTY.

The group includes: H. W. Lockwood, F. J. Cree, J. A. Reynolds, T. H. Gray, D. Spring (Australia), W. H. Moore, V. Delport, T. D. Miller (South Africa), A. C. Turner, and W. Thomas.

After passing through the Thames Valley the party reached Swindon in time for luncheon. The afternoon was spent visiting the foundries and erecting shops at the G.W.R. works. Through the courtesy of Mr. Evans, the foundry manager, members were allowed to examine in detail the foundry plant and methods of production of locomotive cylinders, rail chairs, brake blocks and also the various intricate castings required in non-ferrous alloys in railway construction. The visit was completed by examining the locomotive erecting and maintenance shop, where such operations as boiler construction, frame erection, tyre shrinking, etc., were in progress.

After the visit, a run through the beautiful Cotswold country terminated at Cheltenham, where the party spent the night. On the morning of May 11 the works of Newman, Hender & Company, Limited, at Woodchester, were visited. The party was welcomed by Mr. C. P. Newman, and subsequently visited the foundry and machine shops, under the guidance of Mr. Roy Newman and Mr. Marsland. Here valves of every conceivable size and in all types of alloys were seen in production. Of great interest was the works organisation system whereby every operation from the core shop to the final inspection of the finished valve was carefuly scheduled. Members were entertained to luncheon, Mr. C. P. Newman acting as host.

In the afternoon, an hour's drive brought the party to Chippenham, where the works of the Westinghouse Brake & Signal Company, Limited, were visited, under the guidance of Mr. E. Potts and his colleagues. Here all the most intricate and complicated castings, in both iron and non-ferrous alloys, involved in modern railway and motor transport braking equipment were examined. Some of the castings were like the true foundryman's nightmare, with ports and passages running in all directions, and each has to be subjected to an individual pressure test. Some of the members then visited the signal-erecting shops and were able to compare the strength of arm required to operate the older type of manual signal box, with the gentle effort called for in the new electric equipment as now being installed in some of the large main-line stations. Mr. Cruse, the works manager, welcomed the party at tea.

In the evening the members travelled to Bath, where they spent the night at the Spa Hotel. The first event of the evening was to make friends with the Chief Constable, who had previously been stationed at Rochester. His contact with the latter city had apparently brought him into close touch with one prominent member of the party. Having made their peace with the local authorities, members sallied forth in small groups to find the waters of Bath, but the strange thing is that still no member seems to know just what they taste like!

The third day, May 12, was devoted to a visit to the works of Petters, Limited, at Yeovil. Here the foundries and machine shops were inspected and the famous Petter oil engine examined in all its stages of construction. The party was subsequently entertained to lunch by Mr. T. B. Keep, the managing director, and Mr. Wrinch, works manager, whilst Mr. James, the foundry manager, also added to the enjoyment of the visit.

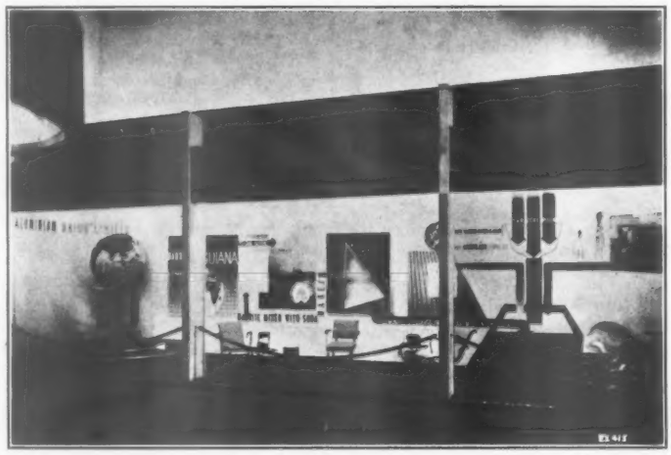
After luncheon the long return journey was started in the first rain seen by most for several weeks. The route lay through beautiful country, and charming old-world towns and villages. The only event of interest on the journey was a short breakdown, the engine "petering-out." The combined advice of the party included inquiries as to whether there was any petrol left, whether there was any spark, and suggestions that the driver should put his tongue on a plug to try. When the engine again sprang into life, the wiser members started murmuring about air locks and such like evasive troubles.

Finally, London was reached in the early evening, and the party broke up after agreeing that, in the words of the poet, "a good time was had by all."

The organising committee came in for a little criticism because the tour had not included a visit to the new Lister foundry at Dursley, but it should be remembered that this plant has only been working a few months, and the directorate desired that it should be running under established routine conditions before inspection by members of the Institute. An invitation is promised for the not too distant future.

Aluminium at the Empire Exhibition

Our illustration shows the stand of Aluminium Union, Limited, Bush House, London, W.C.2, in the Canadian Pavilion of the Empire Exhibition, Glasgow. The back walls of the stand portray the process of the production of aluminium from mine to market. An attractively illustrated booklet has been produced dealing with the general uses of aluminium, and some 50 copies of it are being distributed from the stand each day. Not only is this booklet printed in four languages, but the central insert carrying striking illustrations of the applications of aluminium has created a new note in technical publicity. The letterpress is interestingly written, and the layman will thus have a well-balanced appreciation of aluminium's place in modern industry and the life of the "man in the street."



STAND OF ALUMINIUM UNION, LIMITED, AT EMPIRE EXHIBITION.

At a meeting of engineers in London last week, Sir John Thornycroft presiding, it was decided to form an Engineers' Guild, "to promote the social and economic welfare of the engineer, to stimulate public service in the profession, to encourage and develop the efficiency of the engineer, and to promote unity in the profession." A council of 15 was elected, with a temporary constitution for a year. It was agreed that membership be restricted to members of the Institutions of Civil, Mechanical, and Electrical Engineers and the Institution of Naval Architects.

The New Factories Act—V

THE HOURS OF EMPLOYMENT PROVISIONS

By F. J. TEBBUTT

The Hours of Employment provisions applying to industry have been altered considerably by the new Factories Act. These obligations, of course, do not apply to any adult male worker but only to women (18 years and upwards) and young persons (males and females under 18 years). The working week (meaning exclusive of meal and rest times) must not exceed 48 hrs., and the working day 9 hrs. The employment daily period (meaning working hours and meal and rest times) must not exceed 11 hrs., and must not commence before 7 a.m. or end later than 8 p.m., or in the case of young persons under 16, 6 p.m. On Saturday (or other short day allowed) the ending time must not be later than 1 p.m. By Regulations, however, the commencing hour may be earlier, but not before 6 a.m., this being where the Home Secretary is satisfied that the exigencies of the trade and the convenience of the workpeople are better served by work commencing at an earlier hour than 7 a.m.

After June 30, 1939, the weekly working hours for young persons under 16 are to be 44 hrs. By Regulations, however, and following an inquiry, these hours for particular classes or descriptions of trades or factories can be increased to 48 hrs. a week.

Overtime

A certain amount of overtime may be worked by women and young persons of 16 years and over, but overtime must not exceed a total of 100 hrs. in any calendar year or 6 hrs. in any week, and the factory must not work overtime in more than 25 weeks in any calendar year. The daily working hours (exclusive of meals, etc.) must not exceed 10 hrs., the employment period must not exceed 12 hrs., and the ordinary commencing and ending hours cannot be departed from, except for women, when the ending hour may be 9 p.m. on any week-day but Saturday. Power is given the Home Secretary to reduce the total of overtime on representations being made to him and after inquiry and consultation with an employers' and employees' association, a joint industrial board, a trade board or similar body. By Regulations, where there is seasonal or special pressure of work, the permitted daily work and employment hours may be increased for women only, but only for eight weeks in a year. Under this rule, also, overtime can be increased to 150 hrs. in any calendar year, young persons' overtime being limited, however, to 100 hrs.

By Regulations, as to any classes or descriptions of trades (if the exigencies of trade require it), the permitted weekly overtime or the number of weeks' overtime a year may be increased. By Orders issued individually to particular firms the Home Secretary can permit similar increases, but only in cases of unforeseen pressure of work due to sudden orders, machinery breakdown or other emergency.

By the general provisions the computation of overtime limits is made by the factory, but if the Home Secretary is satisfied that the nature of the trade demands, Regulations may provide that the computation may be by the individual. Under these rules, however, overtime for each individual must not be in excess of 75 hrs. a year for a woman (50 hrs. for young persons), exceed 6 hrs. a week, or be worked for more than 25 weeks in any year.

Five-Day Week

Where a five-day week is worked, the daily hours may extend to 10 hrs. (10½ hrs. with overtime; women and young persons of 16 years), and the period of employment to 12 hrs. If a firm works under this five-day rule, it may, notwithstanding, employ any person on a sixth day (young persons must be 16 years, however) of the week provided the hours worked on that sixth day do not exceed 4½ hrs. and no overtime is worked on any other day of that week; such sixth-day work will count as overtime.

Special Points

No spell of work can proceed beyond 4½ hrs. continuously without at least half an hour interval for a meal or rest (if a 10 min. break is given the spell can run 5 hrs.). Boys of 16 and upwards, if working with men, and their employment with the men continuously is necessary, can work for 5-hr. spells without a meal or rest break.

In connection with young persons employed in the collection, carrying, or delivery of goods, carrying messages or running errands, roughly meaning employment wholly or mainly outside the factory, slightly different hours will rule, although the total working hours a week ordinarily must not exceed 48 hrs. (44 hrs. from July 1, 1939, for young persons under 16), as follows. No spell of work must exceed 5 hrs. without a meal interval of at least half an hour; if the hours of employment include the hours from 11.30 a.m. to 2.30 p.m., a dinner interval of at least ¾ hr. must be allowed between these hours; on one weekday in each week the young person concerned must finish work at 1 p.m. Between mid-day on one day and mid-day on the next day, there must be a non-working interval of at least eleven consecutive hours, and this interval must include the hours from 10 p.m. to 6 a.m. Overtime is allowed, but a young person must not work individually more than 6 hrs. in any week or 50 hrs. in any calendar year, and an employer cannot use young-person labour overtime for more than 12 weeks (consecutive or otherwise) in any year. Sunday work by women and young persons is ordinarily prohibited.

Boys of 16 years and over who are employed in certain trades and processes (given presently) can be employed on a system of shifts and outside the hours explained earlier. A shift system can commence not earlier than 10 p.m. on a Sunday evening, and can end not later than 6 a.m. on a Sunday morning. That applies ordinarily; if the shift system is a four-shift system with 8-hr. turns, they may be employed in such shifts between 6 a.m. and 10 p.m. on Sundays. The following conditions, however, must always be observed: no boy must work more than six turns in any week; the interval between successive turns must be at least 14 hrs.; and no such boy must be employed in two consecutive weeks between 12 midnight and 6 a.m. These conditions may be modified by Regulations in the case of four-shift working. The total hours worked under any shift system can exceed 48 hrs. a week (the overtime rules do not apply, however), but must not exceed 56 hrs. in any week or 144 hrs. in any continuous period of three weeks.

The foregoing provisions apply where the work is carried on continuously day and night, and a young person working under a shift system of this kind must be certified as fit for such employment by the examining surgeon.

For other work (not necessarily continuous) a fitness certificate is not required, but the shift system must be confined to hours between 6 a.m. and 10 p.m. on weekdays; otherwise all the special conditions as regards turn working and the averaging spread-over system as regards working hours for three weeks, as above, will apply; furthermore, the Home Secretary has power to issue such other conditions by Regulations as may be considered necessary for safeguarding the welfare of such young-person workers. The processes to which this exception to the general rules apply include the following:—Processes in which reverberatory or regenerative furnaces, necessarily kept in operation day and night in order to avoid waste of material and fuel, are used in connection with the smelting of ores, or in connection with such other classes of work as may be specified by Regulations of the Secretary of State.

It should be noted that this Act does not interfere with the Employment of Women and Young Persons Act, 1936, which allows shift systems to be worked under certain conditions, these being as follow:—Each shift must not average more than 8 hrs. a day and the system can only operate between 6 a.m. and 10 p.m. every weekday except Saturday, when the shifts must be between 6 a.m. and 2 p.m.

If a five-day week is worked, a shift can be up to 10 hrs. per day, but any week must not aggregate more than 48 hrs., nor any consecutive two weeks 88 hrs. This Act, which applies to women, irrespective of age, and to young persons of 16 years and over (either sex), does not operate generally, but by special authorisations of the Home Secretary given to the particular firm concerned.

The Factories Act provides that ordinarily all women and young persons must have the intervals for rest and meals at the same time, but the Act also provides for exceptions to this rule, meaning that the obligation will not apply to persons on work in processes necessarily continuous; to different sets of employees in different processes or to sets of employees necessarily divided into sets for convenience as regards mess room accommodation, or to other different sets approved by the Factory Inspector. The Home Secretary also has power, if there are special circumstances, to except other trades from this obligation; *there is a special Regulation excepting iron and steel foundries as regards male young persons.*

Employment cannot be carried on during any rest or meal interval, or certain rooms be used during such intervals, but an exception is given to this rule by the Act as regards male young persons employed in the manufacture of iron and steel.

In respect to the prohibition of the use of rooms during rest and meal intervals, the prohibition will not ordinarily apply where persons are employed in processes necessarily continuous, where different sets have different rest or meal times, and as regards any interval allowed in a spell of continuous employment. Regulations can be made bringing in special trades for this exception rule; *there is such a Regulation as regards male young persons in iron and steel foundries.*

No person under sixteen must be employed in a factory unless a certificate of fitness of the young person in question has been obtained. Certifying is by the officially-appointed surgeon—now called the Examining Surgeon—and consists of an entry in the General Register. This officer can either give a clear certificate or a qualified one stating that the person concerned should only be employed on certain operations. As an example, he may consider that a young person should only be employed on a certain job if spectacles are worn and may certify accordingly. By Regulations the Home Secretary can exempt from this obligation any class or description of factory in which mechanical power is not used; this is contrary to present law, where such premises are only included (called at present "workshops") by special mention in Regulations.

This Act makes clear that the employment provisions of the Act relating to women do not apply to women holding responsible positions of management who are not ordinarily engaged in manual work. Incidentally this provision is also in the Hours of Employment (Conventions) Act, 1936, which applies internationally as well as nationally to industrial undertakings.

Institute of British Foundrymen

LANCASHIRE BRANCH ANNUAL MEETING

The annual general meeting of the Lancashire Branch of the Institute of British Foundrymen was held in the Engineers' Club, Manchester, Mr. R. A. Jones (Branch-President) presiding.

Annual Report

The annual report was presented by the HON. SECRETARY (Mr. J. E. Cooke), who said it was pleasing to be able to record steady progress in membership and finance. The total subscription income from members was £14 14s. more than in the previous year, and the total Branch expenditure was £17 18s. 7d. less than the expenditure in 1936.

At the end of the financial year there was a net gain of two members, making the total 376, in spite of numerous transfers of members to other Branches. The Burnley Section had continued its advance in usefulness and influence, and there had been improved attendances at Junior Section meetings.

Exceptionally successful works visits had been organised, 86 participating in the visit to Vickers-Armstrongs at Barrow-in-Furness, and 124 members and friends meeting the West Riding Branch members on a joint visit to Newton, Chambers, Limited.

During the summer 40 members had attended the annual picnic to Knaresborough, 30 had made up an organised theatre party, and the winter session had opened with 86 people at the October social. The attendance at the annual dinner was 207.

The winter lectures had attracted audiences which averaged 87, and the experiment of holding two evening meetings proved satisfactory in point of attendance, the innovation providing opportunities for those members who found Saturday engagements inconvenient. The Syllabus Committee would be considering all the factors for and against evening meetings. with a view to affording the widest possible facilities for the greatest possible number of members.

Relations had been maintained with other technical societies, and members had taken part in the Conference held by the Joint Committee on Materials and their Testing, comprising ten local technical associations, and in a joint meeting with the Manchester Metallurgical Society.

In the wider field of Institute activities, nine Lancashire Branch members served on various Committees, and representatives had attended General Council meetings in various parts of the country, where the proposals of the Board of Development had been carefully discussed. The report of the Organisation Committee, making important proposals affecting every member, would, it was expected, shortly be laid before the whole membership of the Institute.

The Diploma of the Institute has been awarded during the year to Mr. R. Ballantine (Mossend) and to Mr. E. W. Wynn (Cannock) for Papers presented at Lancashire Branch meetings.

At the last annual general meeting the illness of Mr. Harry Stead, assistant secretary, and a former hon. secretary of the Branch, was reported. The Branch Council lost a greatly respected member when, several weeks later, Mr. Stead passed away, and his valued service as a colleague and personal friend could not be allowed to pass without kindly remembrance.

In conclusion, Mr. Cooke gratefully acknowledged the loyalty and support of Branch and Section members and officers, and of the General Secretary and his staff.

MR. J. HOGG (Burnley), in proposing the adoption of the Annual Report, observed that reference had been made to the evening meetings being well attended. It was entirely for the members to decide whether evening meetings should be continued in addition to the Saturday afternoon meetings. The past year's activities had been very successful.

MR. R. A. MILES (Manchester) seconded the adoption of the Annual Report, and also expressed his appreciation of the excellent manner in which it had been prepared and presented. It was extremely pleasing that the Branch continued to prosper, and that Mr. J. E. Cooke was still giving that splendid service which had always been given by the hon. secretaries of the Lancashire Branch.

The Annual Report was then approved and adopted.

Vote of Thanks to Retiring Officers

MR. J. JACKSON (Accrington) proposed a hearty vote of thanks to the retiring President and officers for their services during the past year. The President had been, in many ways, a very outstanding officer of the Branch; it was owing to his initiative that the Lancashire Branch had supported certain competitions, thus broadening the interests of the Institute. The other officers had also fulfilled their duties in a pre-eminently satisfactory manner.

MR. D. MALONE (Accrington) seconded the vote of thanks, which was carried by acclamation.

The BRANCH-PRESIDENT (Mr. R. A. Jones), in responding, said that his year of Presidency had been a year of happiness. Every member of the Council had done his best to expedite the progress of the Branch, and although there might have been occasions when differences of opinion occurred at the Council meetings, yet the members remained the best of friends. Any subject discussed at a Council meeting was thoroughly investigated, to the great advantage of the Lancashire Branch in particular and the Institute generally.

In conclusion, Mr. Jones appealed to all the members to give their whole-hearted support to the President-elect, Mr. H. V. Grundy, whose election he formally proposed.

Election of Branch-President

MR. T. MAKEMSON, in seconding, said Mr. Grundy was one of the oldest members of the Institute, and had always taken a very active part in its management. His interest had also been extended to the welfare and instruction of the junior members. As a foundryman, he had held a position of great responsibility for many years.

The newly-elected President, MR. H. V. GRUNDY, then took the chair, and after thanking the members, said the occasion certainly represented a culminating point in his long association with the Branch, which he joined in 1912. It was his hope and his ambition that, during his year of office, he would be enabled to give the best service possible, and that the Branch would prosper not merely as a result of the efforts put forward by himself but because of the co-operative efforts of the whole of the members.

Election of Vice-Presidents

MR. GRUNDY then proposed the election of Mr. A. L. Key as Senior Vice-President, who had fulfilled the position of Junior Vice-President throughout the past year, and, moreover, had on a previous occasion held the office of President.

MR. R. A. MILES seconded the motion, saying that Mr. Key had held the position of President of the Branch, but immediately after being elected he had accepted a post in Nottingham, where his duties prevented him from giving the service to the Branch which he felt he ought to do.

The motion was carried unanimously, and MR. KEY, in expressing his appreciation of the honour paid to him, said he hoped to justify the support and loyalty which had been shown to him in the past by all the members of the Branch.

MR. GRUNDY proposed the election of Mr. W. Holland as Junior Vice-President, and MR. KEY seconded. The motion having been carried, MR. HOLLAND suitably responded.

Election of Other Officers

The following officers, who were unopposed, were re-elected:—Mr. J. E. Cooke as Hon. Secretary, Mr. F. A. Harper as Assistant Secretary, and Mr. J. Jackson and Mr. A. Phillips as representatives upon the Technical Committee for one year.

Upon a ballot being taken, Mr. R. R. Hargraves, Mr. G. Studley and Mr. A. J. Hinton were elected members of the Branch Council for three years; Mr. W. N. Cook, Mr. J. Jackson, Mr. R. A. Jones and Mr. R. A. Miles were elected representatives to General Council for one year; and Mr. R. R. Hargraves and Mr. A. Hopwood, auditors for one year.

A Generous Donation

The PRESIDENT (Mr. Grundy) announced that he had been requested to make it known to the meeting that Mr. R. A. Jones had generously offered to donate £100 to the Lancashire Branch of the Institute. The interest accruing from its investment was to be used for the provision of a medal which would be presented annually to any member of the Branch who had been adjudged to make the best contribution to the discussions of the various Papers read during the year. In addition, Mr. Jones was prepared to give £20 towards the cost of providing the die from which the medals were struck. Such a generous action on the part of the retiring President should not go by without the members recording their hearty thanks. In the past, several people had given sums of money to the Institute, but not to Branches. Coming after the Coronation Gift, which the retiring President had already made, it was doubly incumbent upon them suitably to record their deep appreciation of his act.

MR. T. MAKEMSON proposed with sincere pleasure that the Branch tender their thanks to the retiring President for his generosity. The members had already heard the opinion that had been expressed of the work done by Mr. Jones during his term of office as President. This gift, together with the other gifts he had made, indicated his enthusiasm for the work of the Institute in general, and for the work of the Branch in particular. It was a most difficult matter to maintain a very high level of discussion, and Mr. Makemson suggested that the retiring President was imbued with the desire to raise the standard of discussion, and encourage those members who had something useful to contribute to the discussions, but who were somewhat diffident about doing so. The President's offer was the most generous gift the Branch had received from any one individual. They could wholeheartedly assure him that his gift would be administered to the very best ability of the Branch Council.

MR. SHERBURN seconded the vote of thanks, which was carried with great enthusiasm.

MR. R. A. JONES, called upon to respond, said he was convinced that the foundry industry derived a great deal of benefit from the discussion of technical Papers, sometimes more than from the reading of a Paper itself. The reason he had made the gift was because he so much liked reading the discussions.

An Old Member

MR. R. A. MILES announced that Mr. W. H. Sherburn had attained his 85th birthday that day. He proposed that a congratulatory telegram be sent to him, wishing him good health and happiness. He was still interested in the foundry industry and in educational matters. The proposal was enthusiastically agreed to.

Moulding Sand, with Special Reference to Blind Scabs*

By S. CARTER and A. W. WALKER

Papers on moulding sand practice have recently occupied the most prominent position in foundry technical literature, and this appears to signify the growing importance which the foundryman attaches to the correct control of this raw material. There are still many otherwise enlightened foundrymen, however, who still seek to claim precedence for the old-fashioned, unorganised and inconsistent systems of sand treatment which were universal before the war. Generally speaking, the individual craftsman was then allowed to prepare his own sand from the raw materials to suit his own taste, with the result that a diversity of results was produced concurrent with the number of moulders employed. When all the arguments about the merits of present-day craftsmen (which are usually derogative) compared with those of a previous generation have been exhausted, there is surely so much in favour of direct supervision and control of sand as to inhibit entirely any discussion on merit.

Without entering into detail, it is sufficient to note that such points as consistency of sand supplied to the operatives, coupled with the certain knowledge that the best sand condition has been attained, the reduction in costs due to better moulding properties, the uniformity of product from man to man, and, what is most important, from order to repeat order, qualify sand control, in the authors' opinion, as representing an immense stride in the slowly proceeding scientific emancipation of the foundry industry.

It is certain that, in the future, foundries without some method of sand control will eventually become redundant, although the authors do not wish it to be inferred that they consider sand control purely from a mechanisation point of view. This method certainly facilitates closer and easier control, and for those who can afford the outlay there is no doubt that handsome savings, outside the scope of this Paper, can be effected. Sand investigation by the very uninitiated cannot fail to bring forth some enlightenment, and the absorbing and interesting results which are obtained usually whet the appetite for further research.

Jobbing Foundry Application

The Papers on sand control which have appeared recently appertain, with few exceptions, to foundries operating on repetition or standard lines. Mechanical systems are usually much more difficult to operate in a jobbing foundry, and with this in mind the authors decided to build this Paper around the practice obtaining in one of the foundries with which they are connected, where the work is strictly of a jobbing character of very wide variety.

Prior to the preparation of this Paper, the excellent articles on the subject of sand by Buchanan, Hudson, Sheehan and others were examined very thoroughly, and such points of interest and controversy culled from them which appeared to have a fundamental bearing on the work to be undertaken. The authors desire at this point to make acknowledgement to the various authors concerned, and to express their admiration of the value of the pioneer work so ably performed.

About three years ago, at the foundry under consideration, it was decided to institute control of the sand and its preparation, and to evolve, if possible, a sand which would function without radical alteration for the production of all classes of casting, *i.e.*, green sand and dry sand or loam. This was considered to be one of the most important points to be borne in mind, as it was felt that the operation of a mechanised plant would be very much simplified by operating a sand which could, with minor adjustment, be subjected to the same treatment without the interferences and stoppages which would be necessary when trying to obtain different mixtures and qualities. With the valuable co-operation of Mr. B. L. Broadbent, managing director of T. Broadbent & Sons, Limited, of Huddersfield, for whom the plant was designed, Pneulec, Limited, supplied the sand mixing and handling machinery, and operations were commenced on the foregoing basis.

On the assumption that a heavily bonded, highly permeable new sand would be necessary to provide the desired standard of mixed material, and also on account of the fact that less new sand additions were now contemplated, a proprietary sand, such as is used by many steelfounders, was chosen as likely to provide the desired results. The properties of this sand showed it to possess a remarkably high permeability value for so heavily bonded a sand, and in addition the bulk of the sand grains were so notably regular in size that it was thought an ideal base sand had been found. The properties of this sand at 6 per cent. moisture were permeability 120, and green bond strength 14 lbs. per sq. in.

TABLE I.—*Grain Growth after 21 Days, the Only Addition being 5 per cent. Coal-Dust after Each Cast.*

Moisture.	A.F.A. Permeability.	G.B.S. Lbs. per sq. in.	Grain size.		
			Pass. 60.	On 60.	On 30 and above.
5.75	64.6	5.1	38	47	15
5.75	66.7	4.8	38	45	17
6.0	66.7	4.7	37	50	13
5.75	58.9	4.0	36	43	21
5.75	66.7	3.8	30	47	23
5.5	64.6	3.3	33	40	27
5.75	62.6	3.2	30	40	30
5.75	62.6	3.0	29	36	35
5.5	64.6	2.8	28	36	36

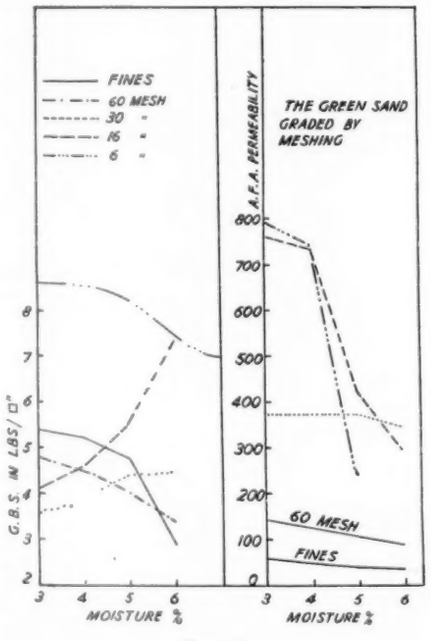


FIG. 1.

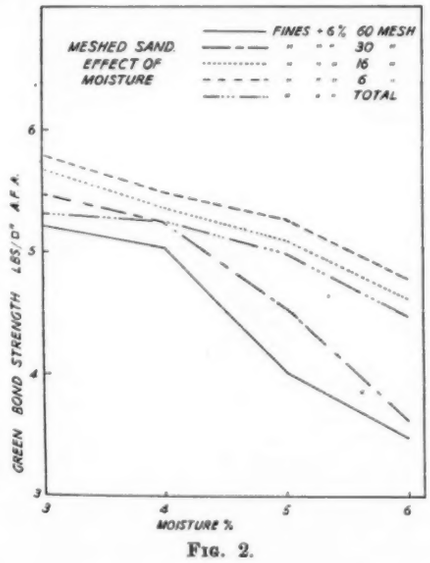


FIG. 2.

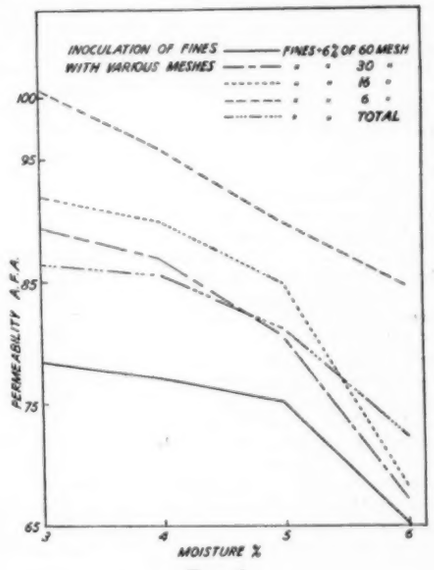


FIG. 3.

It should be noted that all test figures on sand shown in this Paper have been derived from the A.F.A. apparatus.

The figures sought for green sand were permeability 65 and green bond strength 6 lbs. per sq. in. at 5½ per cent. moisture. Trouble was experienced almost immediately due to the tendency of the sand to scab, and after investigation this proprietary sand was thought to be responsible. Although an apparently excellent material, it was found that the bond was so unevenly distributed as to cause a considerable amount of clay to exist as pellets, and even the intensive mixing now taking place was unable to blend them properly with the sand.

It has since been learned that, at the time, this sand was synthetically produced by adding lump clay to a naturally bonded sand, and that the addition of the clay in a finer state of division has improved the sand in this respect. Another reason for the cessation of the use of this sand was that, owing to the excellent preparation now taking place in the mixers, the inert bond in the floor sand was being developed

* A Paper read before the West Riding of Yorkshire Branch of the Institute of Britis-h Foundrymen, Mr. A. S. Worcester presiding. The authors are on the staff of T. Broadbent & Sons, Limited, of Huddersfield.

so that little or no new sand was required for a period. Actually the plant operated for the first twelve months, in cycles of six to eight weeks, without the addition of new sand or bonding material of any description, interspersed with occasional weekly periods when small new sand additions were made.

With the reduction in the use of new sand, a marked improvement in finish was obtained, and when the time arrived for systematic new sand additions some twelve months after commencement of the system, the benefits of control were apparent. The point then arose as to which kind of new sand should be added to make up for the rising deficiency in bonding material. Hensall sand, cheaply obtainable in the locality and very popular in the district was tried first, but the results were disappointing owing chiefly to its lack of bonding power. The open nature of the sand also caused the permeability figures to rise and consequently prejudiced the finish on the green-sand castings.

In view of this, the more heavily bonded, finer grained Mansfield sand was substituted, and with the exception of occasional experimental runs with Pickering sand, the plant has operated until recent weeks on the following mixture, with periodic extra new sand additions when it was found that the bond strength was deteriorating:—Floor sand, 672 lbs.; Mansfield sand, 6 lbs.; and coal-dust, 12 lbs.

Such a mixture can only just maintain the sand in its desired state, and as all sand from whatever source was being put through the system, it was necessary from time to time to add higher proportions of new sand. Recently it has been found more efficacious to add the bonding material in the form of colloidal clay, and the results obtained so far have justified the departure from the previous system of using raw sand. When dry sand is required, the same mixture of sands is used with the elimination of coal-dust. The moisture is raised to 7½ per cent. and wood pulp is added at the rate of 0.3 per cent. for providing the extra dry strength in the sand. Loam also is made from the same source, except that the moisture is of course much higher.

TABLE II.—*Effect of Ramming on Raw Hensall Sand.* (*A.F.A. Apparatus.*)

Test no.	Permeability.	G.B.S. Lbs. per sq. in.	No. of blows.	App. density.	
1	72.3	4.9	3	1.489	
2	66.0	5.7	4	1.540	4 per cent. moisture content.
3	62.0	5.7	5	1.516	
4	60.6	5.7	6	1.522	1st series.
5	69.4	4.1	3	1.525	
6	63.2	4.6	4	1.563	6 per cent. moisture content.
7	61.0	4.7	5	1.560	
8	55.5	5.5	6	1.579	2nd series.
9	73.0	3.6	3	1.533	
10	65.2	3.6	4	1.562	8 per cent. moisture content.
11	60.3	4.4	5	1.570	
12	60.6	4.6	6	1.588	3rd series.
13	52.2	2.8	3	1.627	
14	49.1	2.9	4	1.642	10 per cent. moisture content.
15	45.2	3.3	5	1.655	
16	40.8	3.3	6	1.761	4th series.

The Silt Question

A point worthy of note in view of the wide divergence of opinion on the silt question, is the covered bins situated above the sand mills. These bins are receptacles for the sand delivered from the foundry by way of the belt and elevator, and were originally made without tops. It was found, however, that the wind in the partially open building in which they are housed was exhausting the fine material in the sand to the detriment of the casting finish, and on account of this it was found necessary to protect the sand as it lay in the bins.

TABLE III.—*Effect of Ramming On Pickering Sand.* (*A.F.A. Apparatus.*)

Test no.	Permeability.	G.B.S. Lbs. per sq. in.	No. of blows.	App. density.	
1	52.8	9.9	3	1.455	
2	42.9	13.7	4	1.489	4 per cent. moisture content.
3	42.7	15.8	5	1.508	
4	41.0	17.0	6	1.509	1st series.
5	67.5	12.7	3	1.473	
6	53.7	15.6	4	1.535	6 per cent. moisture content.
7	45.2	17.2	5	1.556	
8	44.2	17.2	6	1.653	2nd series.
9	49.1	9.4	3	1.537	
10	47.8	11.6	4	1.595	8 per cent. moisture content.
11	40.8	13.8	5	1.604	
12	40.8	14.9	6	1.617	3rd series.
13	40.9	8.6	3	1.630	
14	42.9	10.2	4	1.635	10 per cent. moisture content.
15	36.0	11.1	5	1.681	
16	36.0	11.7	6	1.686	4th series.

About this time several experiments were made in connection with the silt problem, and the breakdown and possible accretion of grain size were particularly studied. A series of cast-iron bars was made on twenty-one consecutive days, the sand used being that in general use throughout the foundry. After each cast, the casting was carefully removed, the adhering sand brushed off into the bulk, 5 per cent. coal-dust was added and after treatment the next cast was made. Samples of sand were taken from every cast and the bars produced, 1¼ dia. by 15 in. long, were examined to ascertain the effect on the skin. The castings obtained showed the increase in grain size which took place over the twenty-one casts, and the results are set out in Table I.

It will be observed that the sand grains gradually increased in size as the casts progressed, indicating that the fine material allies itself with the larger grained particles to form a larger composite grain. Other experiments on the same lines have since confirmed this result. It was then decided to find out how the bonding material was distributed throughout the sand which was used in the system. Samples were taken and meshed into their respective grades and Figs. 1 to 3 show the respective bonding values at differing moisture contents, also the effect of inoculating bulk fines with 6 per cent. of each of the other grades in separate ranges. The results of these tests indicate that the bonding value of this particular sand lies in the 16-mesh grade, and not, as is commonly supposed, concentrated in the fine material. That this latter may not be the case in dealing with raw sand from the quarries the authors would not deny, but the effect of foundry conditions, with the continuous rubbing and movement, enables the larger grained material to lick up the finer sand and effectively to increase its size much in the way of a rolling snowball. These results indicated to the authors that when sand is controlled the "problem" of silt need not arise.

TABLE IV.—*Effect of Ramming on Raw Mansfield Sand.* (*A.F.A. Apparatus.*)

Test no.	Permeability.	G.B.S. Lbs. per sq. in.	No. of blows.	App. density.	
1	35.3	6.9	3	1.527	
2	34.1	8.2	4	1.532	3 per cent. moisture content.
3	30.1	9.2	5	1.536	
4	29.2	11.1	6	1.568	1st series.
5	37.0	6.7	3	1.532	
6	34.0	7.1	4	1.545	4 per cent. moisture content.
7	32.5	8.9	5	1.579	
8	27.5	8.3	6	1.580	2nd series.
9	36.2	6.6	3	1.558	
10	32.3	7.8	4	1.600	6 per cent. moisture content.
11	29.4	9.2	5	1.624	
12	26.4	9.9	6	1.638	3rd series.
13	33.9	5.4	3	1.58	
14	31.2	5.7	4	1.60	8 per cent. moisture content.
15	26.6	5.4	5	1.60	
16	25.2	6.0	6	1.62	4th series.

Sand Properties Compared

Incidental experiments in connection with this Paper have been carried out on three well-known types of sand popular in the West Riding area of Yorkshire. The object was to compare the properties of the sands at ordinary ramming, but increasing density and its effect on mould values attracted the authors, who have set out the results shown in Tables II, III and IV. Four series of each sand were tested at differing moisture, and it will be observed wherein lie the maximum advantages to be obtained from any of the sands, *i.e.*, the optimum condition. Obviously, any one sand cannot possess all the virtues of an ideal, so that the user must average the properties obtainable which the two extremes of green bond strength and permeability will permit. For example, series 2 of the Pickering results obviously indicates the best and most advantageous condition for the use of this sand.

Table V is of the green sand used in the foundry, but only two ranges of moisture are shown, as anything above or below these extremes produces an unworkable sand. In fact, the high moisture of the second series has so seriously depreciated the value of the sand as to indicate that moisture control in this particular sand lies within very

TABLE V.—*Standard Green Sand.* (*Moisture in First Series, 5 per cent. Moisture in Second Series, 8½ per cent.*)

Test no.	Permeability.	G.B.S. Lbs. per sq. in.	No. of blows.	App. density.
1	67.0	6.3	3	1.55
2	55.5	7.1	4	1.56
3	52.2	7.5	5	1.56
4	52.1	8.8	6	1.58
5	38.5	3.1	3	1.68
6	38.5	3.3	4	1.69
7	32.3	3.5	5	1.72
8	24.4	4.0	6	1.75

close limits. Such an indication points to the fact that all the available bonding material is being utilised to the fullest extent with the moisture at 5½ per cent.

In view of the results just outlined, it may be asked if Pickering sand would not fulfil the

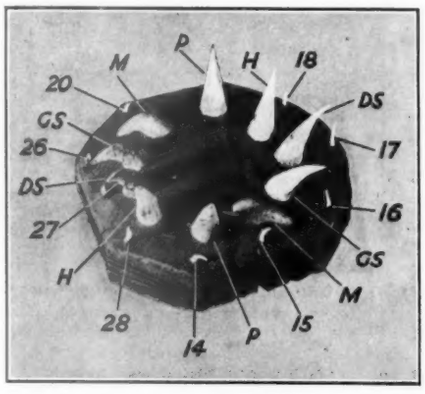


FIG. 4.—SAND CONES WITH SEGER CONES AFTER REFRACTORINESS TEST.

purpose of the new sand addition to the system sand to better effect than the Mansfield, and on the face of it advantages would seem to be apparent. Furthermore, a refractoriness test carried out on cones of these sands showed quite clearly that Pickering sand possesses infinitely superior properties in this respect than does Mansfield. Incidentally, also, it is a very evenly graded material and easy working. In the first place, the authors have evidence from previous tests that yellow sands do not hold their bonding material so tenaciously as do the red sands, that is, they have not the same life; additionally, the full value of Pickering sand was not realised until the experiments were fairly well advanced, and opportunity to try it out in regular practice has therefore been limited. Fig. 4 shows a series of sand cones, placed on a slab of "Durex" together with Seger cones. The letters on the sand cones indicate the type of sand of which they are composed:—P, Pickering; M, Mansfield; H, Hensall; GS, green sand; DS, dry sand. It will be observed that the Mansfield has completely collapsed, while the Pickering has remained intact, the other sands having intermediate fusion temperatures.

Semi-Synthetic Sands

During the past few weeks, as has been previously stated, the sand additions have been substituted by bentonite. Although the system sand may now be considered on the same lines as synthetic sands, it is not truly of this order, the base being composed of naturally bonded material, whereas true synthetic sands are based upon the use of unbonded silica sands with the colloidal clay. The same principle, however, governs the success or otherwise of these mixtures, namely, the proper selection of grain size to suit the type of casting to be produced. Fig. 5 was produced to show the effect of increasing additions of bentonite on the sand in the system, and includes the grain size of the base sand. Figs. 6 to 10 have been introduced to show the comparative effect of bentonite and new sand additions, and with a view to ascertaining, if possible, if there was any essential difference in properties when the test-pieces had stood for varying periods before testing.

Generally, it was found that the strength of the colloidally bonded sands increased more than did those bonded with new raw sand, and this supports the popular contention that sands of this latter type are not so prone to become "murly" upon loss of moisture as are the bentonite sands. Table VI is a consensus of the results obtained on testing the first three weeks' production of sand when using bentonite. The addition of slightly less than ½ per cent. was at first thought to be necessary to produce the standard required, but after a few days it was obvious that fuller utilisation of the bond was being effected, with the result that the additions were cut down successively to approximately ¼ per cent. and later to ⅛ per cent. One important feature of this graph is the effect on the dry bond strength without deleterious effect on any of the other properties of the sand. An objection to the use of synthetic sands is their susceptibility to drying off quickly, a failing quite important to foundries making fairly large moulds. The only remedy is to use a slightly higher proportion of moisture in the sand than is actually required to offset the higher rate of loss.

Dry Sand and Loam

The comments have so far mainly concerned green sand, but this foundry makes the greater proportion of its work in dry sand or loam, and it is here that the greatest advantages of sand control are evinced. The dried strength of the sand is such as to have reduced to a minimum the amount of mould reinforcement necessary, and face sprigging even in front of runners has been entirely eradicated. The casting skin is faultless, and sand troubles in this section are non-existent. The results obtained on dry sand alone have fully justified the installation of the plant, ignoring the economic considerations, which can be very considerable judged from the standpoint of the remarkably small new sand additions and the consequent reduction in the amount of surplus material to be tipped. The properties of the dry sand are as follow:—Green permeability, 66; green bond strength, 3.8 lbs. per sq. in.; moisture, 7½ per cent.; dry permeability, 80; dry bond strength, 65 lbs. per sq. in.

Blind Scabs

Foundrymen on the whole, however, are less inclined to listen to figures than to judge a sand from the effect it has on the quality of the castings which they produce, and the limitations which it imposes on their practice. One of the most difficult and irritating problems with which the foundry has to contend is the occurrence of blind or dumb scabs. Every foundry has had this type of defect, and even in the most well-ordered establishments this trouble occasionally shows itself.

What is the nature of the occurrence which leads to the formation of blind scabs? Every foundryman knows that ramming against the pattern, gaggers too near the face, sleeking newly-wetted faces and excess moisture give rise to scabs of this type. Not many have been able to offer a tangible explanation, however, when it comes to the normal use of an apparently suitable sand. The question of running a mould has an important bearing on the formation of this defect, but as running facilities are limited on most jobs, it seems necessary to understand the combination of reactions which produce this phenomenon, if only to devise means of counteraction.

Hudson has studied this particular phase, and has contributed articles on the results of his examinations. He bases his opinion chiefly on

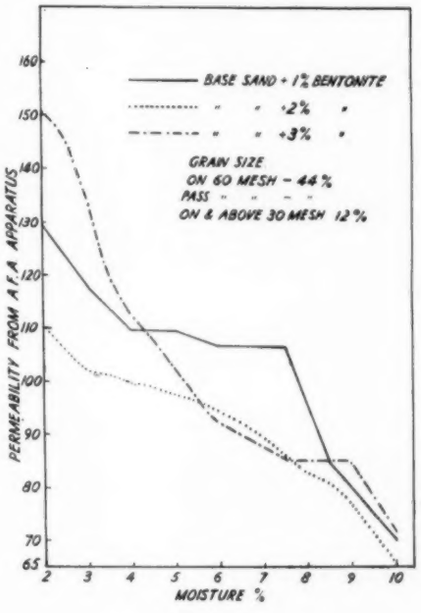


FIG. 5.

certain practical work carried out on a dry-sand mould, and comes to the conclusion that sand expansion is the cause of blind or dumb scabs, or sand buckles as they are termed. On the surface, the feasibility of this explanation provided such a complete answer to this problem as to convince most intelligent foundrymen that herein lay the solution of this difficult question, and the authors confess that they themselves were completely carried away when first the theory of sand expansion was propounded.

Examination of an actual defect served only to support the probability of the theory, and it was only at a later period when actual practical work was undertaken that the authors utterly discountenanced the tenure of this belief. An

TABLE VI.—*Effect of Bentonite on Green Sand.*

Test no.	Moisture.	Permeability.	G.B.S. Lbs. per sq. in.	Dry permeability.	D.B.S. Lbs. per sq. in.	Bentonite. Per cent.
1	5.5	71.8	8	80.6	25.0	0.446
2	5.25	69.4	6.8	79.2	20.0	0.223
3	5.25	69.2	5.6	81.2	27.5	0.15
4	5.0	72.2	6.5	80.6	25.0	0.15
5	5.25	69.8	7.0	79.2	30.0	0.15
6	5.25	66.7	7.0	77.8	30.0	0.15
7	5.25	66.9	6.4	80.6	30.0	0.15
8	5.0	64.6	7.3	78.2	50.0	0.15
9	5.25	66.7	6.2	77.8	45.0	0.15

exhaustive study has compelled them to disagree entirely with the theory of sand expansion as it affects the utility of a mould. While no actual work on the expansion of silica was undertaken, Buchanan, in subsequent contributions on the subject, brought out points that were sufficient to throw some doubts upon the question of sand expansion as published by Hudson, but even granting that the latter's figures were absolutely correct, observation of the phenomenon has indicated that silica expansion has little or no effect in producing a blind scab.

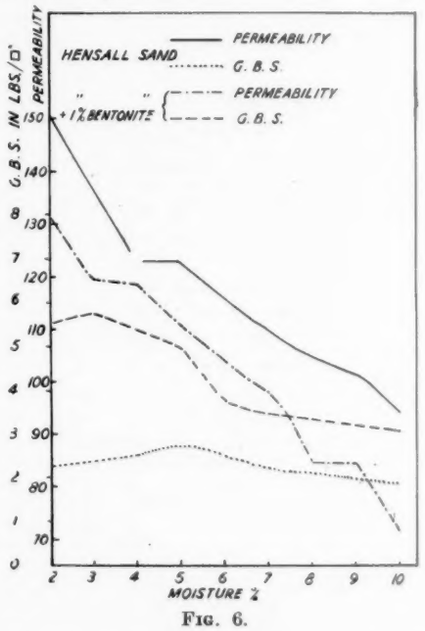


FIG. 6.

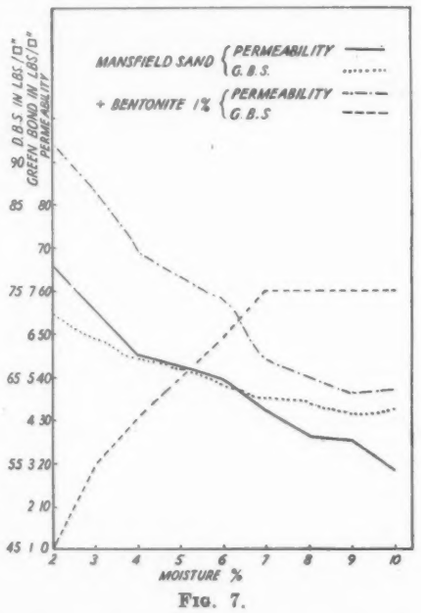


FIG. 7.

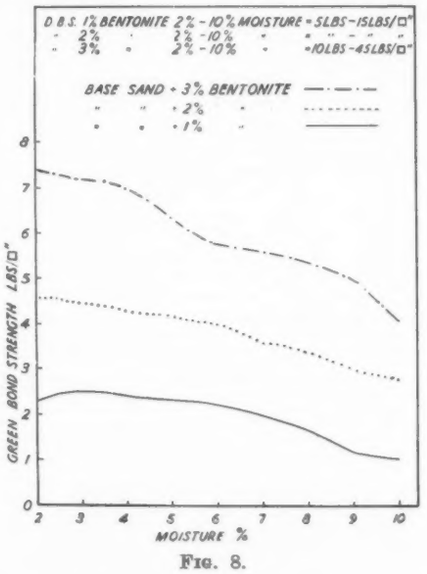


FIG. 8.

To take a simple illustration, assuming the sand expansion in a green-sand mould of one square foot surface area to be equal to that of a dry-sand mould of the same size, it should follow that scabs would be produced with equal facility in a dry-sand mould as in a green-sand mould. Most foundrymen would disagree with such an inference, which is surely discredited in everyday dry-sand practice. Were it possible to

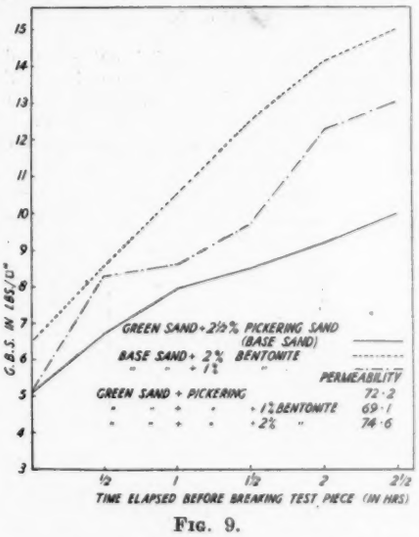

GREEN SAND + 2½% PICKERING SAND (BASE SAND)
BASE SAND + 2% BENTONITE
" " + 1% "
PERMEABILITY
GREEN SAND + PICKERING 72·2
" " " + 1% BENTONITE 69·1
" " " + 2% " 74·6
G.B.S. IN LBS./□"
TIME ELAPSED BEFORE BREAKING TEST PIECE (IN HRS)

FIG. 9.

arrange the sand grains laterally and longitudinally cheek to jowl, it might then be possible to produce something akin to this defect of the blind scab, but air spaces and non-siliceous material in the interstices give any amount of freedom for movement were such an expansion to take place. It is, of course, quite as easy to produce scabs on dry-sand work if the moulds are not properly dried, but throughout the whole course of these experiments a thoroughly dried mould has never blind-scabbed.

Experimental Evidence

It is essential for anyone who wishes to study this problem actually to see the defect in course of formation, and though it would be safe to say that every foundryman has experienced this trouble at some time or other, very few indeed have succeeded in studying its action visibly. Having evolved a theory upon this matter, the authors devised a means whereby the production of blind scabs could be easily watched.

A mould in green sand was made in the shape of a plate 18 in. sq. by ¾ in. thick to cast open, *i.e.*, without cope. The mould was given a 2-in. bank to allow the stream of metal to flow across the plate unhindered until it reached the lip of the mould at the low side which formed the other edge of the plate. At this point, a run-off was cut to allow some of the metal to flow from the mould, thereby preventing the building up of the metal at this point which would ultimately reduce the length of flow across the plate.

One cwt. of hot metal was poured from a single gate about 1½ in. wide, and when the operation of casting was complete, the level of the metal in the mould formed a plate approximately half the size of the mould itself.

Where the rising edge of the metal becomes stationary, the sand immediately in front of it begins to rise up, and a small evolution of gas can often be observed through the broken surface. This self-made vent can often be seen to run along the whole width of the fringe of metal, and when metal is poured over it, a typical dumb scab is made, reproducing perfectly the rift which takes place in the sand.

What appears to occur is that at the edge of the metal stream, either down the side of the runner stream or across the front of the partly-made plate, the sand under the metal, having become relatively dry, is linked up with the green sand still outside the metal with a narrow intermediate crust or scale of sand. Where the dry sand joins the green sand a feather edge of dry material is formed, and this, being the weakest point and subject to the pressure of the gases from under the adjacent metal, is pushed up until the pressure opens the face of the eruption and emits the gas. The light caking action on the sand for a very small distance in front of the metal causes the sand to rise in a very thin layer, and this seems to support Hudson's statement that anything which has a tendency to weaken the sand on casting helps to reduce blind scabbing.

It should be noted that not only is the sand on the edge of the metal in a weak condition due to the crusting effect, but it has to withstand the greatest exertion of pressure generated in the sand underneath the metal adjacent to it. In green-sand plates of large area, portions of the mould which are only sporadically covered with metal show evidence of this effect, an exact corollary of the position when casting the small test plates.

The same evidence is forthcoming on many green-sand plates down the side of the stream of metal as it crosses the plate, and emphasises the desirability of pouring such castings as quickly as possible. Where it is possible to run a plate casting along its whole length by a runner of the "flash" type, or by banking the mould to restrict the metal flow across the plate, sound castings can be produced with regularity. The chief point to be borne in mind is that the

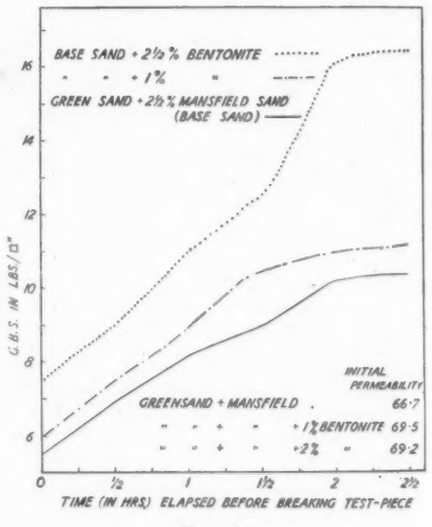

BASE SAND + 2½% BENTONITE
" " + 1% "
GREEN SAND + 2½% MANSFIELD SAND (BASE SAND)
INITIAL PERMEABILITY
GREENSAND + MANSFIELD . 66·7
" " + " + 1% BENTONITE 69·5
" " + " + 2% " 69·2
G.B.S. IN LBS./□"
TIME (IN HRS) ELAPSED BEFORE BREAKING TEST-PIECE

FIG. 10.

blind scab is formed before the metal reaches the actually defective area, and, moreover, standing metal appears to produce the effect to a greater extent than does flowing metal. Balanced runners do a great deal to mitigate the trouble when it is found to be due to stationary pools of metal on the mould surface.

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  (FOR CYLINDERS, ROLLS, ENGINEERING CASTINGS, ETC.)
- Low Carbon Malleable
  (FOR MALLEABLE CASTINGS OF ALL DESCRIPTIONS)

Supplied to any specification between limits of 2·00 and 3·50% Carbon and ·50% and 3·50% Silicon

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TOTAL CARBON	2·70%
SILICON	1·80%
MANGANESE	·90%
SULPHUR	·06%
PHOSPHORUS	·40%

- **Typical Malleable Pig Iron Specification**

TOTAL CARBON	2·60%
SILICON	·75%
MANGANESE	·50%
SULPHUR	·05%
PHOSPHORUS	·06%

WARNER & CO. LTD
MIDDLESBROUGH

It is one thing to find out how a defect is caused and quite another to devise remedial action. Quack cures which may function in a particular sphere, but which are generally detrimental in other respects, or the extravagant use of poorly-bonded raw sands do not commend themselves, as they are unnecessarily expensive and show no regard for the issue in question. The authors admit quite frankly that they are not yet in a position to prescribe an absolute cure for the trouble, which they have both experienced, but are in the midst of experiments which indicate the possibility of positive results. Hudson has stated that sawdust reduced the tendency to blind-scab, but, as mentioned above, he attributes this to the reduced expansion from sands made with sawdust additions. The authors suggest that this investigator has attained this result for a different reason from the one advanced, and that while sawdust does tend to reduce blind scabbing, it does so not because of the reduced expansion values, but because sawdust cannot be effectively bonded with sand and so breaks up the continuity or homogeneity of the sand, and in places where such scabbing is likely to occur thus prevents the formation of the lightly baked crust of bonded material by its weakening action thereon. The very nature of sawdust, however, makes it foreign to the functions of a moulding sand, and in the authors' opinion difficult to control, and although undeniably a palliative, it savours very much of being "any port in a storm."

Non-Scabbing Sand

Many foundrymen differ in their opinions about the effect of temperature or permeability on the production of this defect, but the authors are prepared to state quite categorically that blind scabs are not a reciprocal of temperature or correlated with permeability. The tests carried out have embraced aluminium and brass plates as well as iron, the lowest pouring temperature being 600 deg. C. and sand permeability values from 22 to 295 A.F.A., and blind scabs have resulted with equal facility from both extremes. During the whole of the series of tests, in whatever sand, the only moulds to stand definitely perfectly were made from a mixture of floor sand of approximately 40 permeability to which was added 10 per cent. mineral blacking, the moisture content being 6 per cent. Such moulds have to be cast immediately after preparation, however, otherwise the sand is inclined to run after losing moisture.

An old-established claim for coal-dust in connection with blind scabbing also merits attention. Hird, in his notable articles on this material, attributes this property of coal-dust to the formation of a tarry residue produced when coal is heated, the result being a sort of bond which is said to provide elasticity and reaction against the expansion of the sand. The fundamental reason, of course, why coal-dust is incorporated in sand is to produce the carbon film which affords some protection from the metal. Blind scabs are formed, however, in outlying sand, that is, not under the metal, and the tarry substance said to be produced would not be present in the thin scale of sand which is just in front of the metal stream. Therefore it is evident that the defect is in existence before the coal-dust has functioned in this respect.

A further point which goes to disprove this theory is that the firing point of coal-dust is about 97 deg. C., with varying flash-points depending on conditions, up to 500 deg. C. There would, therefore, be no tarry matter in existence within the temperature range which Hudson has proved to be the silica expansion period. The authors are of the opinion that any non-bonding material of the same nature, such as coke dust, or coal ash, would produce the same effect on scabbing for the reasons which apply to sawdust. It is considered that far too much use is made of coal-dust in the general foundry as a palliative for defective practice in other directions, and one wonders when the average foundryman will be educated to the proper use of this material which he uses so slavishly and about which he really understands so little. Metallurgically, foundrymen have been trying consistently to eradicate gas from the metal, while at the same time they continue to use an essential gas producer in the position where it has the best possible facilities for entering the metal.

Coal-dust in excess has been responsible many times when the blame has been attached to the metal for such defects as draws, sinks, dirty and blown castings. An example of this came to the authors' attention during the making of a quantity of bevel gear blanks, a sketch of which is shown in Fig. 11.

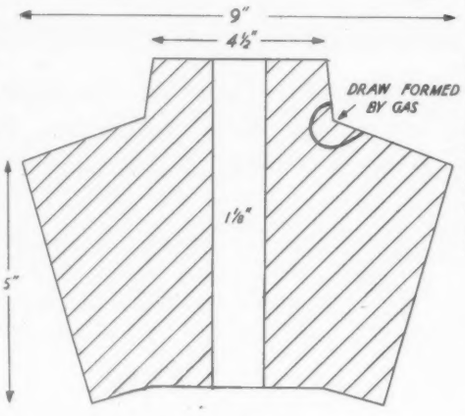

Fig. 11.

The sand used was made up of 10 per cent. Hensall sand, 8 per cent. coal-dust and the rest floor sand, and when the defective castings were examined, the conclusion was formed that the draw existing in the neck, indicated in the sketch, was a gas formation. The order was for 81 pairs, and after the first six castings had been made and the defect found, the rest were made in milled floor sand without coal-dust, without the loss of a single casting. In a subsequent repeat order of the same job, the same result was obtained, the first half-dozen castings exhibiting the defect when using the sand containing coal-dust, and afterwards the balance being made up quite satisfactorily from treated floor sand as in the previous case. The same trouble has been experienced with high-pressure valves cast in green sand; what appeared at first sight to be shrinkage trouble from the metal transpired to be due to coal-dust, which caused a hot spot to be formed at the sharp corners of sand where the flanges meet the body. Elimination of the coal-dust cured the trouble. One axiom to be borne in mind is that the lower the permeability of the sand, the less can coal-dust be used with any degree of safety.

Table VII.—*Dry Strength and Permeability of Loam. (Moisture 20.4 per cent.)*

Test no.	Dry strength.	Permeability.
1	65	22.8
2	65	30.1
3	50	38.0
4	53	30.8
5	57	26.5
6	62	25.0
Average	58.6	28.86

Loam Sands

Some tests on loam have been incorporated with a view to showing the widely differing properties obtainable from one kind of sand when varying the moisture content. The loam is made from the same sand as the dry sand used at this foundry, with the exception that the wood pulp is omitted. Facing loam as set out in Table VII is made up with 20 per cent. moisture, and for the benefit of those who are not conversant with this type of sand it should be pointed out that the low dried permeability value is the result of the excess moisture which thins the bonding material to such an extent as to obtain the maximum cementing action upon the body of the sand. The relatively high dry-bond strength figures are attributable to the same reason.

In conclusion, the authors would say that they consider this Paper largely as an introductory effort which could undoubtedly have been enlarged upon at a later date, but they hope that they will have contributed sufficient data to arouse the interest and criticism which any work on such an important subject requires.

The authors' thanks are due in large measure to Mr. B. L. Broadbent, managing director of T. Broadbent & Sons, Limited, for permission to present this Paper and for the unstinted support which he has accorded, also to the directors of Kaye & Company (Huddersfield), Limited, for permission to carry out certain practical work. The authors are also indebted to Mr. F. Poole, of Keighley Laboratories, for his kind assistance in the preparation of slides, and to Pneulec, Limited, for the loan of slides of the plant.

Joint Committee on Materials and their Testing

The Joint Committee on Materials and Their Testing, which now comprises twenty-five Institutions and Societies, have recently issued their annual report, which points out that the first general discussion organised by the Joint Committee was devoted to the subject of Notched-Bar Impact Testing and the meeting was held at Manchester on October 29, 1937, under the ægis of the Manchester Association of Engineers. The meeting was well attended and a most useful and interesting discussion took place.

Arrangements are in progress for the second general discussion, which will centre round a group of Papers on various aspects of Non-Destructive Testing, including the use of X-rays and gamma-rays and magnetic, electrical, acoustic and general methods. As in the case of the first discussion, it is intended to invite Papers from selected experts with the object of presenting and recording the general state of knowledge and current opinions. Steps have accordingly been taken to secure Papers from Germany, Holland and the United States, as well as from this country. The discussion will take place in November next under the ægis of the Institution of Electrical Engineers, and details will be announced in the near future.

By arrangement, the Joint Committtee have taken over the duties of the British Committee of the International Association for Testing Materials. The London Congress of the International Association for Testing Materials—the first to be held in this country—took place in April, 1937, the Proceedings of which were published on December 31, 1937. Dr. H. J. Gough, F.R.S., continues to represent Great Britain on the International Permanent Committee.

The Council of the Institution of Mechanical Engineers have kindly afforded office accommodation, and communications regarding the work of the Joint Committee should accordingly be addressed to its Secretary, care of the Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W.1.

The Hon. James Russell Rea has been appointed secretary of the British Electrical and Allied Manufacturers' Association.

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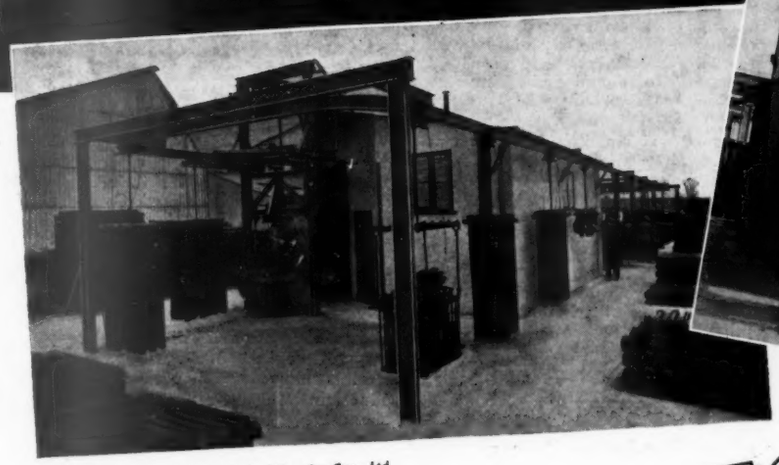

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The Week's News in Brief

Trade Talk

KEIGHLEY ASSOCIATION OF ENGINEERS will hold its annual general meeting at the Victoria Hotel, Keighley, to-morrow (Friday), at 8 p.m.

A PARTY of about 450 employees of Aiton & Company, Limited, pipe founders, of Derby, are to visit the Empire Exhibition at Glasgow on June 18.

ABOUT 30 MEMBERS of the Derby Society of Engineers visited the works of the Universal Grinding Wheel Company, Limited, Stafford, last week.

AN ORDER for a 275-ft. motor-ship of 3,050 tons for the Union Steamship Company of New Zealand has been received by Henry Robb, Limited, of Leith.

LOBNITZ & COMPANY, LIMITED, Renfrew, have received an order from the International Danube Commission for a rock-cutter required for the Cataract and Iron Gates sector of the Danube.

JOHN BROWN & COMPANY, LIMITED, Clydebank, have secured an order for an 11,000-ton cargo and passenger vessel for the Federal Steam Navigation Company, a subsidiary of the New Zealand Shipping Company.

MARSHALL, SONS & COMPANY (SUCCESSORS), LIMITED, of Gainsborough, announce that an interim dividend of 2½ per cent., less income tax, will be paid in respect of the financial year ending September 30, 1938.

THE £225,000 TENDER of Dorman, Long & Company, Limited, of Middlesbrough, for the reconstruction of Menai suspension bridge has been accepted by the Minister of Transport. Work will start within the next few weeks.

A NEW AGREEMENT with Australia which will be fairer to Great Britain is urged by the Federation of British Industries in a statement sent to the Government. The Federation points out that far from securing any appreciable increase in the share of the import trade of Australia, the United Kingdom suffered a net loss of £3,299,000 in 1935-36 compared with 1931-32. The loss to the metal manufacturers was £2,672,000.

THE FEDERATION OF BRITISH INDUSTRIES, pointing to "the intensive national propaganda carried out by certain foreign countries in support of their commercial and industrial interests," is of opinion that British propaganda on a wider scale is urgently required. The Federation has approached Sir Robert Vansittart, chairman of the recently appointed committee to co-ordinate national propaganda, in the hope that funds will be provided by the Government expressly devoted to national industrial propaganda that would not come within the province of individual industries or firms.

Obituary

MR. CHARLES WILLIAM CATT, a director of Henry Berry & Company, Limited, engineers, of Leeds, has died at his home at Leatherhead, Surrey.

THE DEATH occurred on May 18 of Mr. Thomas Mowat, managing director of Harpers, Limited, founders and engineers, of Craiginches, Aberdeen. He was over 70 years of age, and was President of the Aberdeen branch of the Engineering and Allied Trades Association. Mr. Mowat had been connected with the firm for over 50 years.

KOMMERZIENRAT DR.-ING. E.H. FRIEDRICH SPRINGORUM, a distinguished member of the Westphalian community of iron and steel industrialists, died on May 16 at Essen in his 81st year. Dr. Springorum devoted practically the whole of his industrial life to the Eisen und Stahlwerk Hoesch, where he became works manager in 1891 at the age of 33. In 1898 he joined the board of the concern, becoming managing-director in 1905. Under his control the Hoesch works were converted from a re-rolling concern to a composite steelworks owning blast furnaces, iron ore mines and collieries, and one of the largest of its kind in Germany. In 1920 he retired in favour of his son, Dr.-Ing. Fritz Springorum, who was chairman of the reception committee on the occasion of the annual meeting of the Iron and Steel Institute at Düsseldorf in September, 1936.

Personal

DR. R. P. LINSTEAD has been appointed to the Chair of Chemistry at Sheffield University, from which Prof. G. M. Bennett has resigned.

MR. W. J. E. BINNIE has been elected President of the Institution of Civil Engineers for 1938-39, and will succeed Mr. S. B. Donkin on November 1 next. Vice-Presidents elected are Sir Clement Hindley, Mr. M. F.-G. Wilson, Sir Leopold Savile and Prof. C. E. Inglis.

MR. ROBERT CRICHTON, for nine years director and general manager of the United Steel Companies' branch at Workington, and who resigned his position at the end of 1937, recently received presentations which had been subscribed for by members of all departments of the company.

LIEUT.-COLONEL JOHN COLVILLE attains Cabinet rank by his appointment as Secretary of State for Scotland. Formerly a director of David Colville & Sons, Limited, and other steel and engineering companies, Col. Colville has been Financial Secretary to the Treasury since 1936.

MR. T. B. KEEP (managing director of Petters, Limited), Mr. J. R. Greenwood (chairman, Craven Bros. (Manchester), Limited), Sir H. Brent Grotrian and Mr. A. P. Good (chairman, Petters, Limited), have joined the board of the Brush Electrical Engineering Company, Limited.

Wills

FAWCETT, P. W., late managing director of the Park Gate Iron & Steel Company, Limited, Rotherham, and a director of Thomas Firth & John Brown, Limited, Sheffield	£58,760

Foundry Pig-Iron Prices

At a meeting in London last Thursday of the Foundry Pig-iron Producers' Association it was decided to make no alteration, on July 1 next, in foundry and forge pig-iron prices. It was announced early in the year that no change in prices would be made before June 30, and there has been speculation recently as to the probable level of prices over the second half of the year. Buyers have been holding off the market and the announcement that there will be no change on July 1 may be expected to result in more active conditions.

A Fresh Milestone in the Development of Cast Iron

(*Concluded from page* 419.)

cases, and especially when alloyed with proportions of nickel, be subjected to a quenching and tempering treatment to give a further improvement in mechanical properties. By means of such heat-treatment it is possible frequently to give an increase in tensile strength of as much as 30 to 50 per cent., and by suitable adjustment of tempering conditions the hardness of the final castings may be held over a wide range of limits. Such treatment generally improves wearing quality, and is of great interest for many parts in machine construction, such as small rollers, cams and gears.

Apart from this type of heat-treatment, it has been found by experience that in high-duty castings of all types a low-temperature stress anneal is of great advantage where this can be included in the manufacturing programme. In the case of castings bought to grades 2 and 3, and especially in the case of castings of complicated shape, a low-temperature anneal at, say, 450 deg. C. for a suitable time (*e.g.*, one hour for a casting of 1 in. average section and weighing up to ½ ton), not only eliminates any necessity for ageing, but also adds appreciably to the strength and impact resistance of the iron.

New Companies

(From the Register compiled by Jordan & Sons, Limited, Company Registration Agents, 116 to 118, Chancery Lane, London, W.C.2.)

A. C. James, Limited, 76, Aston Street, Birmingham.—Capital, £1,000. Brassfounders.

Anchor Metal Company, Limited.—Capital, £1,000. Subscriber: A. Fletcher, 38, Wildwood Road, Hampstead, London, N.W.11.

Johnson & Dudley, Limited, 147, Great Hampton Road, Birmingham.—Capital, £500. Brassfounders. Directors: T. G. Johnson and T. F. Johnson.

Low Moor Iron Company (Successors), Limited, Lincoln House, High Holborn, London, W.C.1.—Capital, £2,000. Directors: O. F. Grazebrook, C. J. Grazebrook, T. N. Ballantyne and W. H. B. Hatton.

Applications for Trade Marks

The following list of applications to register trade marks has been taken from the "Trade Marks Journal":—

"TENSOVIC."—All goods included in Classes 6 and 13. Metropolitan-Vickers Electrical Company, Limited, Kingsway, London, W.C.2.

"GREVAK."—Pipe fittings. R. A. Greenwood, 17, Bolan Street, London, S.W.11.

"TRAFFODOL."—All goods included in Class 1. Metropolitan-Vickers Electrical Company, Limited, Kingsway, London, W.C.2.

Grey Iron Foundry Control

(*Concluded from page* 418.)

Costing

It is difficult to separate metallurgical control from costing in a repetition foundry, where materials may cover 50 per cent. of the cost of production. The metallurgist should always consider proposed changes from the company's point of view. For repetition work, common pig-iron and cheap scrap simply are not a paying proposition, and all such materials should be selected for consistency rather than on primary cost. Foundry costing is now occupying a large share of the attention of foundry executives, and deservedly so, because it is definitely very lax. There is just one point worthy of expression on this subject which may seem at variance with accepted beliefs—why are so many arguments waged over "the cost of the metal at the spout"? Why does one need to consider the value of shop returned scrap at all? The author fails to see any need for a value of either. The melting shop need no more be considered separate from the foundry. All that is necessary for material cost of repetition castings is the *cost per ton of good castings.*

This is arrived at by taking the total value of issues of raw materials to the foundry and dividing by the tonnage of good castings which emerge from the fettling shop in a certain period, neglecting altogether, for costing purposes, the fact that there may be 50 per cent. metal returned for re-melting beforehand. In "total raw materials issued," one includes all bought-out consumable stores, but no plant maintenance. Wages for moulding, melting, casting and fettling are fairly easy to analyse and allocate individually. In the foundry with which the author is connected this allocation is rendered especially easy by the system of "time-piece-work" labour control.

Forthcoming Events

JUNE 21-24.

International Engineering Congress:—To be held at the Empire Exhibition, Bellahouston Park, Glasgow.

Institute of British Foundrymen

JUNE 14-17.

Thirty-fifth Annual Conference at Bradford.

The Institute of Vitreous Enamellers

JUNE 4-6.

Whitsun Conference at Glasgow.

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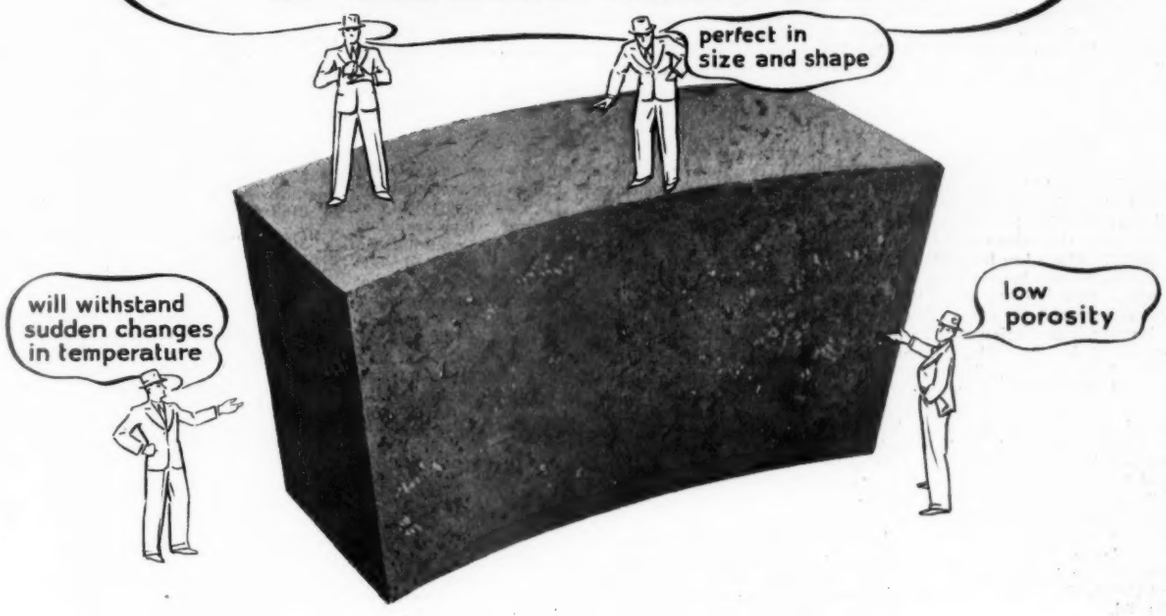

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SWANSEA OFFICE: Metropole Chambers, Wind Street. Telephone: 3680. Telegrams: "Genefax, Swansea." (Mr. D. F. Hood-Williams).

MANCHESTER OFFICE: 9, Albert Square. Telephone: Blackfriars 6130 Telegrams: "Genefax, Manchester." (Mr. S. G. Throssell).

MIDDLESBROUGH OFFICE: Halifax Bldgs., Exchange Place, Telephone: Middlesbrough 3313. Telegrams: "Genefax, Middlesbrough." (Mr. J. A. Williams).

BIRMINGHAM OFFICE: 5, Lower Temple Street, Telephone: Midland 6376. Telegrams: "Genefax, Birmingham." (Mr. G. Griffiths).

Raw Material Markets

At a meeting in London on Thursday last, the Foundry Pig-iron Producers' Association decided that no change would be made in foundry and forge pig-iron prices on July 1. No doubt this announcement will cause some disappointment among consumers, many of whom had anticipated lower quotations for deliveries after the end of the first half of the year. Nevertheless, now that the question of prices has been cleared up, consumers are expected to place orders for deliveries ahead. No definite date has been fixed when quotations will again come up for revision.

Pig-Iron

MIDDLESBROUGH.—Although most consumers are already well stocked with supplies of pig-iron, it is expected that additional orders will be placed now that it is known that there will be no change in prices on July 1. There has been little new business about recently, buyers hoping that it would be to their advantage financially to await the decision of the makers with regard to prices. No. 3 Cleveland G.M.B. foundry iron continues to be quoted at 109s. per ton, No. 1 foundry 111s. 6d., and No. 4 foundry and No. 4 forge 108s., all delivered in the Middlesbrough and Falkirk areas and subject to 5s. per ton rebate.

The output of hematite in this area has been further reduced, but producers' stocks remain very heavy, and current demands are insufficient to make any pronounced impression on these supplies. Apart from the quietness of the home market, export inquiries are completely absent; makers are offering supplies to foreign consumers at prices well below those quoted at home, but, even so, competition abroad continues to be too keen. For delivery on the North-East Coast, East Coast mixed numbers are quoted at 132s. 6d.

LANCASHIRE.—The fact that consumers may now transact business further ahead than the end of June may induce them to make new contracts, although there has been no improvement in working conditions. Further orders, however, may be expected from the heavy electrical engineers and the machine-tool makers, who are well employed. For delivery to users in the Lancashire price zone, offers of Derbyshire and Staffordshire brands of No. 3 foundry iron are on the basis of 114s., less 5s. rebate, with Northamptonshire at 112s. 6d., and Derbyshire forge iron at 111s. to 113s., according to the class of consumer. The demand for hematite remains quiet. Prices, including delivery to Manchester and district, are 141s. for West Coast iron, with East Coast material at 140s. 6d.

MIDLANDS.—Activity in the building trade continues to decline, and, as a result, light-castings makers continue to be poorly engaged. It had been expected that an improvement would have materialised before this time of the year. Other branches of the pig-iron consuming industries remain unsatisfactorily employed and new business is still quiet. Some concerns are certain to take the opportunity of booking additional tonnages for delivery later in the year now that they are able to do so. Producers, generally, are in the position to meet new business from stock. There is a fairly good demand for hematite, while low-phosphorus iron is also well taken up. The latter is quoted at £5 15s. to £7, according to quality. It is possible, of course, to book hematite up to the end of the year and many consumers have done so, while others are merely entering into hand-to-mouth transactions. Only a small amount of business is going through in refined iron. The Association quotes a minimum of £8 5s., but this figure is being considerably lowered by furnaces outside of the Association.

SCOTLAND.—It is unlikely that consumers will place orders for very large tonnages of foundry iron in the near future, as stocks remain heavy. The stabilisation of prices, however, may have some effect in releasing further inquiries. Production, both of foundry iron and hematite, has been reduced during the past week. No. 1 foundry iron is quoted at 120s. 6d. and No. 3 at 118s., f.o.t. furnaces. Local steelworks are not taking up large tonnages of pig-iron, as they are well stocked, but activity remains on a good scale. Steel-making irons are quoted at 133s. for hematite mixed numbers, 107s. 6d. for Scottish basic, and 100s. for English and Indian basic, less 5s. per ton rebate, delivered f.o.t. steelworks.

Coke

Consumers are refraining from taking up further supplies of foundry coke until they are able to obtain easier quotations. At present, makers are firm in their attitude that prices will remain at their current levels until the end of the year. For delivery to Birmingham and district, best Durham coke is quoted at 55s. 9d., with Welsh coke at from 55s. to 62s. 6d.

Steel

Lethargic conditions rule in the steel market, but large tonnages continue to pass into consumption against existing contracts. In most departments of the market considerable stocks exist, which are being absorbed rather slowly. Business in semi-finished steel is restricted by the stocks of imported steel at consumers' works. These, however, are being slowly liquidated, but, in the meantime, new business in British material is severely limited. Irregular conditions continue to rule in the finished steel department, but most of the heavy-steel works have orders in hand which will take some time to complete. The situation in the lighter branches of the industry is not so good, and in some departments operations have been slowed down. Export trade is quiet.

Scrap

There is little alteration to report in the condition of the iron and steel scrap market from week to week. Only small tonnages are changing hands, as most consumers have substantial tonnages in stock. The steelworks, which are very large users, have no need to negotiate for additional supplies, having sufficient on hand to last for a considerable time ahead, in addition to which their production tends to decline.

Metals

The non-ferrous metal markets have experienced a very quiet time during the past week. Copper, particularly, has been adversely affected by the prevailing dull conditions.

Copper.—This market has been very dull during the past week, and prices have slumped considerably. The quotation touched £34 5s., which is the lowest level for several years. The demand for copper from Continental consumers appears to have slackened off rather surprisingly of late; during recent months European business has been very substantial. Imports into Germany have been on a high scale this year, but, so far, the German authorities have refrained from divulging the extent of the deliveries in April. As a result, it has been impossible to compile the usual statistics. Imports of copper into Germany last year were on an average monthly level of 18,983 metric tons. During the first two months of 1938 that country imported copper at the rate of 24,442 tons, and the figures for April are expected to reveal that about 30,000 tons of copper entered Germany from abroad during that month.

The price of domestic copper in the United States has been reduced to 9 cents per lb., delivered Connecticut Valley. This represents a decrease of 1 cent. and brings the quotation down to the lowest level since 1935. The price of copper scrap has also fallen, and now stands at 7¼ cents per lb. The price movement in America came as something of a surprise, as it had been expected that producers would have been able to maintain the existing quotation. It is unlikely that the lower price will have any stimulating effect on business.

Metal Exchange quotations were as follow :—

Cash.—Thursday, £37 2s. 6d. to £37 3s. 9d.; Friday, £35 1s. 3d. to £35 2s. 6d.; Monday, £34 2s. 6d. to £34 5s.; Tuesday, £34 to £34 2s. 6d.; Wednesday, £33 5s. to £33 6s. 3d.

Three Months.—Thursday, £37 7s. 6d. to £37 8s. 9d.; Friday, £35 6s. 3d. to £35 7s. 6d.; Monday, £34 7s. 6d. to £34 10s.; Tuesday, £34 5s. to £34 7s. 6d.; Wednesday, £33 10s. to £33 11s. 3d.

Tin.—Business in this market continues to be dull. Tinplate mills in South Wales are operating at under 34 per cent. of capacity, while United States mills are working around 47½ per cent. The weekly market report issued by Rudolf Wolff & Company states that " from the point of view of demand, there is little that is fresh to report. There is still a good deal of uncertainty as to the result of the buffer project, and it must be always borne in mind that, whatever steps may be taken by producers, the ultimate future of the market must depend on the ability of the industry to assimilate the tin, and this can only follow a real and lasting industrial revival, particularly in America."

It is understood that the result of the Malayan referendum has been communicated to the Colonial Office in London, but no announcement has been forthcoming from that source as yet. It is rumoured, however, that the voting revealed a decisive majority in favour of the buffer pool.

Official quotations were as follow :—

Cash.—Thursday, £162 5s. to £162 10s.: Friday, £158 5s. to £158 10s.; Monday, £159 10s. to £160; Tuesday, £161 to £161 5s.; Wednesday, £162 15s. to £163 5s.

Three Months.—Thursday, £162 15s. to £163; Friday, £158 15s. to £159; Monday, £160 5s. to £160 10s.; Tuesday, £161 15s. to £162; Wednesday, £163 10s. to £163 15s.

Spelter.—New orders are not coming to hand in sufficient numbers to keep prices from falling still further and the tone of the market remains unsatisfactory. Stocks at the producing plants are accumulating, while there is a steady decline in consumption.

Daily market prices :—

Ordinary.—Thursday, £12 11s. 3d.; Friday, £12 6s. 3d.; Monday, £12 7s. 6d.; Tuesday, £12 11s. 3d.; Wednesday, £12 10s.

Lead.—A further reduction was recorded in building plans passed during the month of April. The decline over the first four months of the year now totals 16.2 per cent. Plans passed in April at £8,178,700 were 24.1 per cent., lower than for the corresponding period of last year. The unsatisfactory condition of the building trade is reacting adversely on many branches of the lead-producing industries.

Day-to-day quotations :—

Soft Foreign (Prompt).—Thursday, £13 16s. 3d.; Friday, £13 8s. 9d.; Monday, £13 11s. 3d.; Tuesday, £13 17s. 6d.; Wednesday, £13 15s.

Scrap.—Although there has been some slight expansion of demand recently, the scrap market continues to be quiet and only a small amount of business is passing.

Approximate selling prices for old metal:—New aluminium cuttings, £75; rolled, £60; cast, £30; foil, £88. Copper, £35 to £38; braziery, £32. Brass (clean), £21 to £24. Zinc, £7. Lead, £11 10s. Gunmetal, £37.

Contract Open

Stoke-on-Trent, June 15.—625 yds. of cast-iron pipe sewer, varying in dia. from 9 in. to 33 in., for the Town Council. The City Engineer, Town Hall, Stoke-on-Trent. (Fee £5, returnable.)

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SHOT OR SAND BLAST PLANTS
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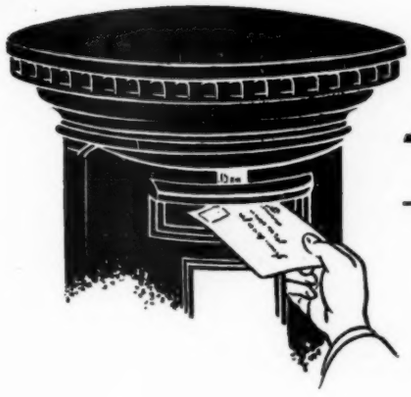

- or write
- to our Technical Service

The B.A. Co. TECHNICAL SERVICE comprises a staff of specialists individually qualified to give expert information on any particular problem. You are invited to avail yourself of their knowledge and experience.

THE British Aluminium CO. LTD

HEAD OFFICE: **ADELAIDE HOUSE, LONDON, E.C.4**

Telephone: Mansion House 5561

Telegrams: "Cryolite, Bilgate, London"

EMPIRE EXHIBITION SCOTLAND 1938

Palace of Engineering
Stands E.38 & E.128

F.T.J. 26/5/38.

RAW MATERIALS—PRICE LIST

(Wednesday, May 25, 1938)

COPPER

	£	s.	d.
Standard cash	33	5	0
Three months	33	10	0
Electrolytic	38	0	0
Tough	37	10	0
Best selected	38	0	0
Sheets	70	0	0
India	50	15	0
Wire bars	39	5	0
Ingot bars	39	5	0
H.C. Wire rods	42	15	0
Off. av. cash, Apr.	39	7	0 9/16
Do., 3 mths., Apr.	39	12	2 1/16
Do., Sttlmnt., Apr.	39	7	2 1/16
Do., Electro, Apr.	43	17	2 1/16
Do., B.S., Apr.	43	12	6
Do., Wire bars, Apr.	44	6	3 1/16
Solid drawn tubes			12d.
Brazed tubes			12d.
Wire			7¾d.

BRASS

Solid drawn tubes	10¾d.
Brazed tubes	12¾d.
Rods, drawn	8½d.
Rods, extd. or rlld.	6d.
Sheets to 10 w.g.	8d.
Wire	7¾d.
Rolled metal	7½d.
Yellow metal rods	6d.

TIN

	£	s.	d.
Standard cash	162	15	0
Three months	163	10	0
English	162	15	0
Bars	164	15	0
Straits	164	15	0
Eastern	168	15	0
Banca (nom.)			—
Off. av. cash, Apr.	168	15	5 1/16
Do., 3 mths., Apr.	169	7	7 1/16
Do., Sttlmt., Apr.	168	15	0

SPELTER

	£	s.	d.
Ordinary	12	10	0
Remelted	10	5	0
Hard	10	0	0
Electro, 99.9	16	8	9
English	13	17	6
India	12	15	0
Zinc dust	18	0	0
Zinc ashes	5	5	0
Off. aver., Apr.	13	16	5 3/16
Aver., spot, Apr.	13	14	6 3/16

LEAD

	£	s.	d.
Soft foreign, ppt.	13	15	0
Empire (nom.)	14	13	9
English	16	0	0
Sheets, home	21	10	0
Do. export	19	0	0
Pipes, home	21	0	0
Do. export	19	10	0
Tea lead	29	12	6
Off. aver., Apr.	15	12	0 1/16
Aver., spot, Apr.	15	11	6 1/16

ALUMINIUM

Ingots	£100 to £105
Wire	1/3 to 1/4 lb.
Sheet and foil	1/2 to 1/4 lb.

ZINC SHEETS, &c.

Zinc sheets, English	27	5	0 to	27	15	0
Do., V.M. ex-whse.	27	5	0 to	27	15	0
Rods				19	0	0

ANTIMONY

English	75	0	0 to	78	0	0
Chinese, ex-whse.				56	0	0
Crude, c.i.f.				33	0	0

QUICKSILVER

Quicksilver	13	15	0

FERRO-ALLOYS AND STEEL-MAKING METALS

Ferro-silicon—						
25%	12	10	0			
45/50%	12	10	0			
75%	17	0	0			
Ferro-vanadium—						
35/50%	14/- lb. Va.					
Ferro-molybdenum—						
70/75% carbon-free	4/9 lb. Mo.					
Ferro-titanium—						
20/25% carbon-free	9d. lb.					
Ferro-phosphorus, 20/25%	£21 to £22					
Ferro-tungsten—						
80/85%	4/8 lb.					
Tungsten metal powder—						
98/99%	4/9½ lb.					
Ferro-chrome—						
2/4% car.	34	15	0			
4/6% car.	24	5	0			
6/8% car.	24	0	0*			
8/10% car.	24	0	0			
Ferro-chrome—						
Max. 2% car.	36	0	0			
Max. 1% car.	38	5	0			
Max. 0.5% car.	41	0	0			
70% carbon-free	10d. lb.					
Nickel—99.5/100%	£180 to £185					
"F" nickel shot	£165	0	0			
Ferro-cobalt, 98/99%	8/6 to 8/9 lb.					
Metallic chromium—						
96/98%	2/5 lb.					
Ferro-manganese—						
76/80% loose	£18	15	0 to	19	5	0
76/80% packed	£19	15	0 to	20	5	0
76/80% export	£22	0	0			
Metallic manganese—						
94/96% carbon-free	1/3 lb.					

Per ton unless otherwise stated, basis 2-ton lots.

SCRAP

	£	s.	d.	£	s.	d.
South Wales (West)—						
Heavy steel, best	3	8	9 to	3	11	3
Mixed iron and steel	3	6	9 to	3	9	3
Heavy cast iron	3	8	9 to	3	11	3
Good machinery	3	10	0 to	3	12	6
Cleveland—						
Heavy steel, best	3	7	0 to	3	9	6
Steel turnings	2	13	0 to	2	15	6
Heavy cast iron				3	10	0
Heavy machinery				3	15	0
Midlands—						
Short heavy steel				3	12	6
Light cast-iron scrap				3	2	6
Heavy wrought iron	4	0	0 to	4	5	0
Steel turnings	2	6	3 to	2	8	9
Scotland—						
Heavy steel best	3	5	0 to	3	7	6
Ordinary cast iron	3	15	0 to	3	17	6
Cast-iron borings	2	0	6 to	2	3	0
Wrot-iron piling	4	5	0 to	4	7	6
Heavy machinery	4	1	6 to	4	2	6

London—Merchants' buying prices, delivered yard.

Copper (clean)	32	0	0
Brass	20	10	0
Lead (less usual draft)	12	10	0
Tea lead	10	0	0
Zinc	6	10	0
New aluminium cuttings	67	0	0
Braziery copper	29	0	0
Gunmetal	31	0	0
Hollow pewter	115	0	0
Shaped black pewter	78	0	0

HIGH-SPEED TOOL STEEL

Finished bars, 14% tungsten	3s. 0d.
Finished bars, 18% tungsten	3s. 10d.

Per lb. d/d buyers' works.

PIG-IRON*

N.E. Coast (d/d Tees-side area)—	
Foundry No. 1	111/6
„ No. 3	109/-
„ No. 4	108/-
Forge No. 4	108/-
Hematite No. 1	133/-
Hematite M/Nos.	132/6
N.W. Coast—	
Hem. M/Nos. d/d Glas.	133/-
„ d/d Birm.	144/6
Malleable iron d/d Birm.	160/-
Midlands (d/d Birmingham dist.)—	
Staffs No. 4 forge	110/-
„ No. 3 fdry.	111/-
Northants forge	107/6
„ fdry. No. 3	108/6
„ fdry. No. 1	111/6
Derbyshire forge	110/-
„ fdry. No. 3	111/-
„ fdry. No. 1	114/-
Scotland—	
Foundry, No. 1, f.o.t.	120/6
„ No. 3, f.o.t.	118/-
Cleveland No. 3, Glasgow	112/-
„ „ Falkirk	109/-
Scottish hem. M/Nos. d/d	133/-
Sheffield (d/d district)—	
Derby forge	107/6
„ fdry. No. 3	108/6
Lincs forge	107/6
„ fdry. No. 3	108/6
W.C. hematite	138/6
Lancashire (d/d eq. Man.)—	
Derby fdry. No. 3	114/-
Staffs fdry. No. 3	114/-
Northants fdry. No. 3	112/6
Cleveland fdry. No. 3	114/-
Glengarnock, No. 3	140/-
Clyde, No. 3	140/-
Monkland, No. 3	140/-
Eglinton, No. 3	140/-
Gartsherrie, No. 3	140/-
Shotts, No. 3	140/-

(* Prices of hematite and basic pig-iron, and of foundry and forge iron with a phosphoric content of not less than 0.75 per cent., are subject to a rebate of 5s. per ton under certain conditions.)

FINISHED IRON AND STEEL

Usual district deliveries.

[A rebate of 15/- per ton for steel sections, plates and joists is obtainable in the home trade under certain conditions.]

Iron—	£	s.	d.	£	s.	d.
Bars (cr.)	13	5	0 to	13	15	0
Nut and bolt iron	11	12	6 to	12	2	6
Hoops				14	2	6
Marked bars (Staffs) f.o.t.				15	15	0
Gas strip				14	2	6
Bolts and nuts, ½ in. × 4 in.				17	10	0 and up
Steel—						
Plates, ship, etc.	11	8	0 to	11	10	6
Boiler plts.	11	18	0 to	12	0	6
Chequer plts.				13	0	6
Angles				11	0	6
Tees				12	0	6
Joists				11	0	6
Rounds and squares, 3 in. to 5½ in.				12	0	6
Rounds under 3 in. to ½ in. (untested)				12	4	0
Flats—8 in. wide and over				11	5	6
„ under 8 in. and over 5 in.				11	10	6
Rails, heavy				10	2	6
Fishplates				14	2	6
Hoops (Staffs)				12	19	0
Black sheets, 24g. (4-t. lots)				15	15	0
Galv. cor. shts. („)				18	10	0
Galv. flat shts. („)				19	0	0
Galv. fencing wire, 8g. plain				20	5	0
Billets, soft, 100-ton lots				7	17	6
Sheet bars				7	15	0
Tin bars				7	15	0

PHOSPHOR BRONZE

	Per lb. basis
Strip	10½d.
Sheet to 10 w.g.	10¾d.
Wire	12¼d.
Rods	12d.
Tubes	18d.
Castings	15d.

Delivery 3 cwt. free.
10% phos. cop. £33 above B.S.
15% phos. cop. £38 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. CLIFFORD & SON, LIMITED.

NICKEL SILVER, &c.

	Per lb.
Ingots for raising	8d. to 1/2
Rolled—	
To 9 in. wide	1/2 to 1/8
To 12 in. wide	1/2¼ to 1/8¼
To 15 in. wide	1/2¼ to 1/8¼
To 18 in. wide	1/3 to 1/9
To 21 in. wide	1/3½ to 1/9½
To 25 in. wide	1/4 to 1/10
Ingots for spoons and forks	8d. to 1/4½
Ingots rolled to spoon size	11d. to 1/7½
Wire round—	
to 10g.	1/5½ to 2/0½

with extras according to gauge.
Special 5ths quality turning rods in straight lengths, 1/4½ upwards.

AMERICAN IRON AND STEEL

At Pittsburgh unless otherwise stated.

	Dols.
No. 2 foundry, Phila.	25.84
No. 2 foundry, Valley	24.00
No. 2 foundry, Birm.	20.38
Basic, Valley	23.50
Malleable, Valley	24.00
Grey forge, Valley	23.50
Ferro-mang. 80%, seaboard	102.50
O.-h. rails, h'y, at mill	42.50
Billets	37.00
Sheet bars	37.00
Wire rods	47.00
	Cents.
Iron bars, Chicago	2.40
Steel bars	2.45
Tank plates	2.25
Beams, etc.	2.25
Skelp, grooved steel	2.10
Steel hoops	2.40
Sheets, black, No. 24	3.15
Sheets, galv., No. 24	3.80
Wire nails	2.75
Plain wire	2.90
Barbed wire, galv.	3.40
Tinplates, 100-lb. box	$5.35

COKE (at ovens)

Welsh foundry	42/6
„ furnace	34/6
Durham foundry	39/6
„ furnace	32/6
Scottish foundry	42/-
„ furnace	35/6 to 37/6

TINPLATES

f.o.b. British Channel ports.

I.C. cokes	20×14 per box	20/3 to 21/6
„	28×20 „	40/6 to 43/-
„	20×10 „	29/-
„	18¾×14 „	21/-
C.W.	20×14 „	19/- to 20/3
„	28×20 „	38/- to 40/6
„	20×10 „	27/-
„	18¾×14 „	20/-

SWEDISH CHARCOAL IRON & STEEL

Pig-iron	£11	0	0 to	£12	0	0
Bars-hammered, basis	£20	0	0 to	£22	0	0
Bars and nail-rods, rolled, basis	£19	0	0 to	£20	0	0
Blooms	£18	0	0 to	£19	0	0
Keg steel	£30	0	0 to	£35	0	0
Faggot steel	£19	0	0 to	£24	0	0
Bars and rods dead soft st'l	£14	0	0 to	£16	0	0

All per English ton, f.o.b. Gothenburg.
[Subject to an exchange basis of Kr. 19.29 to £1.]

DAILY FLUCTUATIONS

Standard Copper (cash)

			£	s.	d.	
May	19	..	37	2	6 dec.	8/9
,,	20	..	35	1	3 ,,	41/3
,,	23	..	34	2	6 ,,	18/9
,,	24	..	34	0	0 ,,	2/6
,,	25	..	33	5	0 ,,	15/-

Electrolytic Copper

			£	s.	d.	
May	19	..	41	0	0 dec.	20/-
,,	20	..	39	10	0 ,,	30/-
,,	23	..	38	10	0 ,,	20/-
,,	24	.	38	5	0 ,,	5/-
,,	25	..	38	0	0 ,,	5/-

Standard Tin (cash)

			£	s.	d.		
May	19	..	162	5	0 inc.	10/-	
,,	20	..	158	5	0 dec.	80 -	
,,	23	..	159	10	0 inc.	25/-	
,,	24	..	161	0	0 ,,	30/-	
,,	25	..	162	15	0 ,,	35/-	

Tin (English ingots)

			£	s.	d.		
May	19	..	162	5	0 inc.	10/-	
,,	20	..	158	5	0 dec.	80/-	
,,	23	..	159	10	0 inc.	25/-	
,,	24	..	161	0	0 ,,	30/-	
,,	25	..	162	15	0 ,,	35/-	

Spelter (ordinary)

			£	s.	d.		
May	19	..	12	11	3 dec.	1/3	
,,	20	..	12	6	3 ,,	5/-	
,,	23	..	12	7	6 inc.	1/3	
,,	24	..	12	11	3 ,,	3/9	
,,	25	..	12	10	0 dec.	1/3	

Spelter (Electro, 99.9 per cent.)

			£	s.	d.		
May	19	..	16	8	9 dec.	2/6	
,,	20	..	16	3	9 ,,	5/-	
,,	23	..	16	5	0 inc.	1/3	
,,	24	..	16	10	0 ,,	5/-	
,,	25	..	16	8	9 dec.	1/3	

Lead (soft foreign, prompt)

			£	s.	d.		
May	19	..	13	16	3 dec.	6/3	
,,	20	..	13	8	9 ,,	7/6	
,,	23	..	13	11	3 inc.	2/6	
,,	24	..	13	17	6 ,,	6/3	
,,	25	..	13	15	0 dec.	2/6	

Lead (English)

			£	s.	d.	
May	19	..	16	0	0 dec.	5/-
,,	20	..	15	10	0 ,,	10/-
,,	23	..	15	15	0 inc.	5/-
,,	24	..	16	0	0 ,,	5/-
,,	25	..	16	0	0 No	change

AVERAGE MONTHLY PRICES OF CLEVELAND No. 3 PIG-IRON.*

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Yearly average
	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
1898	40 9	40 8	40 6	40 0	40 7	39 11	40 4	41 11	43 0	44 11	49 1	44 3	42 0
1899	46 10	47 11	47 9	49 10	55 11	62 10	71 6	65 9	67 7	68 8	70 0	66 9	60 5
1900	67 10	68 10	73 10	76 2	74 2	68 6	69 3	71 4	70 9	67 8	63 6	53 6	68 9
1901	48 0	46 6	45 8	45 5	45 10	44 7	44 6	45 3	45 3	45 3	43 6	43 1	45 3
1902	43 11	46 7	46 9	47 11	48 10	49 7	50 9	52 1	53 6	52 9	50 9	47 11	49 3
1903	47 3	48 9	51 10	49 0	46 1	46 2	46 7	46 8	45 7	43 6	42 10	41 11	46 4
1904	42 3	42 7	43 3	44 7	44 0	42 10	42 9	42 3	43 1	43 9	46 1	48 7	43 11
1905	48 11	48 0	49 6	50 1	51 5	45 6	45 9	47 5	48 8	52 11	52 9	53 3	49 8
1906	53 9	50 1	48 1	48 8	50 2	50 3	50 6	53 0	54 6	56 8	58 6	62 4	53 6
1907	60 4	56 6	54 10	56 0	61 1	58 1	57 8	57 8	55 7	54 8	50 8	50 0	56 2
1908	48 5	49 3	51 7	51 10	51 6	51 2	50 0	51 4	52 0	49 8	49 4	48 11	50 8
1909	48 10	48	46 9	47 9	48 4	48 9	48 6	50 5	51 3	51 11	51 2	50 7	49 4
1910	51 10	51 8½	51 7½	50 10	49 10	49 2	48 10	49 8½	49 3½	49 7½	49 6½	49 10	50 4
1911	49 11½	49 2½	48 5	46 11	46 4	46 6	46 11½	47 4	47 0	46 7	47 4½	48 1	47 7
1912	50 0	49 5½	51 1½	53 7½	54 4	55 1	57 5½	64 6½	61 7½	66 8½	67 8	68 0	58 5½
1913	66 11½	63 8½	64 8	67 1½	66 3	56 9½	56 3½	55 8	55 4	53 0	50 1	50 4	58 10
1914	50 11	51 5½	51 0½	51 4½	51 6	51 6½	51 5	52 3	51 5	50 1	50 3	53 0	51 4½
1915	55 7	56 6	61 0	66 7	65 2	66 10	65 4	66 0½	65 3	65 11	69 10½	75 7½	65 7
1916	80 2	91 6	87 4½	86 10	82 6	82 6	87 6	87 6	87 6	87 6	87 6	87 6	85 10
1917	87 6	87 6	87 6	92 6	92 6	92 6	92 6	92 6	92 6	92 6	92 6	95 0	99 2
1918	95 0	95 0	95 0	95 0	95 0	95 0	95 0	95 0	95 0	95 0	95 0	95 0	95 0
1919	95 0	95 0	95 0	95 0	152 6	160 0	160 0	160 0	160 0	160 0	160 0	160 0	137 8
1920	175 0	175 0	187 6	200 0	208 0	217 6	217 6	221 0	225 0	225 0	225 0	225 0	209 3
1921	222 6	195 0	150 0	126 0	120 0	120 0	120 0	136 3	127 0	120 0	110 0	100 0	*137 4
1922	92 6	90 0	90 0	90 0	90 0	90 0	89 0	87 3	92 6	92 6	92 6	91 3½	90 7½
1923	94 6	108 9	125 6	129 4½	128 5	136 0	128 1½	121 11	97 1½	97 0	100 0	100 0	110 6½
1924	99 10	97 3½	91 9	93 9	91 9	89 10½	87 9	85 0	82 5½	80 2½	81 9	81 9	88 7½
1925	80 4½	78 10½	78 0	78 3	76 0	73 10½	71 7½	69 10½	68 1½	66 7½	66 0	66 10½	72 10½
1926	69 4½	70 0	70 0	70 0	72 6	75 10½	86 7½	90 0	93 10½	117 10	120 0	99 0	86 3
1927	85 0	83 1½	81 0	80 0	73 9	70 0	70 0	68 9	67 6	67 6	66 10½	65 0	73 2½
1928	65 0	65 0	65 6	66 0	66 0	66 0	66 0	66 0	66 0	66 0	66 0	66 0	65 9½
1929	66 0	66 9	67 0	68 1½	69 5	71 10½	72 9	72 6	72 6	72 6	72 6	72 6	70 4½
1930	72 6	72 6	70 0	67 6	67 6	67 6	67 6	64 6	63 6	63 6	63 6	63 6	66 11½
1931	59 6	58 6	58 6	58 6	58 6	58 6	58 6	58 6	58 6	58 6	58 6	58 6	58 7
1932	58 6	58 6	58 6	58 6	58 5	58 6	58 6	58 6	58 6	58 6	58 6	58 6	58 6
1933	62 6	62 6	62 6	62 6	62 6	62 6	62 6	62 6	62 6	62 6	62 6	62 6	62 6
1934	62 6	65 0	67 6	67 6	67 6	67 6	67 6	67 6	67 6	67 6	67 6	67 6	66 10½
1935	67 6	67 6	67 6	67 6	67 6	67 6	67 6	67 6	67 6	67 6	69 4½	70 0	67 10½
1936	70 0	70 0	70 0	70 0	70 0	70 0	75 0	75 0	75 0	75 0	75 0	81 0	73 0
1937	81 0	81 0	81 0	81 0	81 0	81 0	101 0	101 0	101 0	101 0	106 0	106 0	91 10
1938	109 0	109 0	109 0	109 0	109 0	—	—	—	—	—	—	—	—

*Delivered Middlesbrough area for years 1933 and onwards. Prior to 1933, prices were f.o.t. furnaces. NOTE: Prices have been subject to a rebate of 5/- per ton since November 1, 1937.

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